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This serial publication contains articles, abstracts of articles and news items from USSR scientific and technical journals on the specific subjects reflected in the table of contents.

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CONTENTS

PAGE

SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

Eulogy of Vladimir L'ovovich Broude (A. S. Davydov, et al.; USPEKHI FIZICHESKIKH NAUK, Apr 79)	1
Scientific Session of the Department of General Physics and Astronomy of the USSR Academy of Sciences (USPEKHI FIZICHESKIKH NAUK, Apr 79)	4
Briefs Small Industrial Laser	18

ABSTRACTS

Crystals and Semiconductors	19
Electricity and Magnetism	31
Lasers and Masers	33
Nuclear Physics	48
Magnetohydrodynamics	57
Optics and Spectroscopy	58
Optoelectronics	61
Stress, Strain and Deformation	63
Superconductivity	64
Theoretical Physics	66
Thermodynamics	68

EULOGY OF VLADIMIR L'OVOVICH BROUDE

Moscow USPEKHI FIZICHESKIKH NAUK Vol 127 No 4, Apr 79 pp 731-732

[Article by A. S. Davydov, et. al.: "In Memory of Vladimir L'ovovich Broude".]

[Text] On 22 June 1978 Professor Vladimir L'ovovich Broude, a well-known Soviet physicist, winner of the Lenin Prize and doctor of physical-mathematical sciences died suddenly. He is responsible for fundamental results in the area of the spectroscopy of the solid state, primarily in molecular crystals.

V. L. Broude was born in Moscow on 1 December 1924. His father was a well-known biochemist and his mother a doctor. In 1947 Vladimir L'ovovich completed work at the Moscow Institute of Chemical Machinery Building and, as an engineer for cryogenic technology was sent to work in Kiev in the Department of Spectroscopy at the Ukrainian SSR AN [Academy of Sciences' Institute of Physics]. His immediate task consisted in the development and debugging of equipment for low temperature spectral research. However here he very rapidly displayed those qualities which in the future ensured him success in work throughout his life. He immediately moved beyond the boundaries of his immediate engineering obligations, and became thoroughly interested in low temperature spectroscopy itself. He began to study quantum mechanics, the theory of groups, etc. The results were extremely successful: his first work on the spectroscopy of molecular crystals - exciton multiplets in benzene (1951) immediately became a classic. In addition its success was two-fold: purely scientific and methodological. Finally, Vladimir L'ovovich was to some extent led in the right direction - he entered the spectroscopy of molecular excitons just at the time when there was intensive development in this area. However it was in fact the successful work of V. L. Broude on benzol which was one of the definite impulses in this development. It was at this time that the strongly polarizing "crystalline" bands in spectra were experimentally discovered and the theory of exciton multiplets was developed. In his work on benzene V. L. Broude gave the first experimental proof of the identity of the "crystalline" band and exciton multiplets. Therefore work on benzene opened the path to further extensive experimental study of exciton spectra of molecular crystals.

It is very important that in the course of this work microprojectors for photographing low temperature spectra of small microcrystals in polarized light were invented and first used. Therefore this work was also the methodological basis for further study.

The intensive work in later years in which Vladimir L'ovovich took very active participation permitted rapid advances, the accumulation and analysis of extensive experimental material on exciton spectra of specific crystals, their changes during phase transformations, deformations, etc. These results make up the foundations of our present ideas about the general structure of exciton spectra.

In the course of this work a new circle of problems was gradually formulated: the precise and distinct detection of exciton bands in spectra, the determination of the genesis and structure of the exciton zones. Its solution required the development of a system of new experimental methods. The most effective here turned out to be methods based on the study of compound crystals. The basic facts lying at the base of these methods were discovered experimentally in the work of Vladimir L'ovovich Broude with his students.

For example mixed exciton zones were discovered in the spectra of concentrated isotopic solutions (1961). In addition several exciton multiplets were discovered, in accordance with the number of mixture components. This behavior, subsequently observed in various disordered systems received the name multimode. Study of the spectra of isotopic solutions as a function of component concentration permitted the direct observation of the development of the exciton multiplet from the doped bands, thus directly establishing the genetic link between exciton multiplet components and the definitive band in the molecule spectrum. Later gigantic changes in the intensity of impurity bands, their flaring up and elimination were discovered (1961). This permitted the unambiguous delineation of exciton bands, and the determination of the location of the boundaries of exciton zones, etc. Thanks to this work exciton zones in molecular crystals became the same sort of "experimental reality" as electron bands in metals and semiconductors. At this time regular research began on the structure of the zones of molecular excitons in various substances. Vladimir L'ovovich also stood at the source of the dynamic approach to the vibration (electron oscillation) spectra of crystals (1966) permitting the general description of both pure exciton and vibration spectra of pure and doped crystals.

These works of V. L. Broude accounted for a considerable part of the research cycle in the spectroscopy of excitons for which a group of Soviet physicists were awarded the Lenin Prize in 1966.

Immediately after the discovery of the first OKG [optical quantum generator = laser] Vladimir L'ovovich with characteristic enthusiasm actively engaged himself in research on their physical processes. Having gathered a circle of enthusiasts about this new direction around him, in 1963 he created a

department of quantum electronics at the Ukrainian SSR AN's Institute of Physics. This was also the period of his ideas about the use of molecular crystals and their rich transition spectra for tunable lasers and the development of a dispersion resonator.

In 1966 Vladimir L'ovovich transferred to work at Chernovolovka, at the USSR AN's Institute of Solid State Physics. Here he created a laboratory for optics and spectroscopy working in a number of areas of crystal spectroscopy. During this time Vladimir L'ovovich's personal scientific interests became more closely linked to the spectroscopy of molecular excitons at high crystal excitation states. He devoted much time to the creation of experimental equipment with powerful nanosecond impulses necessary for this research. He was crowned with success and in later years Vladimir L'ovovich and his co-workers discovered intensive phonon impulses arising during the relaxation of strongly excited anthracene, and a new emission band which was evidence of the formation of a dense phase of molecular excitons.

Vladimir L'ovovich's contribution to science was not exhausted by his personal achievements. Thanks to his wide scientific interests, his very easy going nature and personal charm, he got along easily with quite different people and eagerly shared his experience and advice with colleagues and with young people beginning work in science. He left behind many scientists to whom he always tried to give his own personal fascination with science and his inexhaustible interest in everything new that came into his field of view. These qualities account for the huge contribution Vladimir L'ovovich made to the formation of a scientific collective at the Institute of Solid State Physics of the USSR AN. Up until the very last, extremely ill and knowing that his illness was untreatable, Vladimir L'ovovich continued to actively work with striking courage and enthusiasm.

The work of Vladimir L'ovovich left a deep mark on science and his memory will always remain in the hearts of his friends and colleagues.

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SCIENTIFIC SESSION OF THE DEPARTMENT OF GENERAL PHYSICS AND ASTRONOMY OF
THE USSR ACADEMY OF SCIENCES

Moscow USPEKHI FIZICHESKIKH NAUK in Russian, Vol 127, No 4, Apr 79
pp 723-730

[Text] On 25 and 26 October 1978 there was a scientific session of the Department of General Physics and Astronomy and the Department of Nuclear Physics of the USSR AN. The following reports were heard at the session:

1. G. S. Krinchik. Magneto-optical Study of Surfaces.
2. A. F. Andreyev. Thermodynamics of Liquids Below Debye Characteristic Temperature.
3. E. Ye. Berlovich. Study of Nuclei far from Beta Stability Regions.
4. V. S. Lezokhov. Detecting Single Atoms and Nuclei by the Method of Laser Spectroscopy.
5. G. N. Flerov, Yu. G. Oganesyan. Synthesis of and Search for Super Heavy Elements.

A summary of the contents of the four reports read are published below.

MAGNETO-OPTICAL STUDY OF SURFACES

The magneto-optic method of studying the surface magnetic properties of crystals¹ is based on the two following assumptions: 1) values of the coefficient of absorption of light in the visible regions during reflection take place in the crystal at a depth of less than 500 Å. 2) The magneto-optic effects of changing intensity of reflected light or rotation of the

plane of polarization are proportional to the magnetization of the ferromagnetic substance. Thus, having determined for a given crystal the proportionality of this coefficient in the saturated domain, one can determine all the fundamental magnetic characteristics of the layer near the surface, measuring the dependency of the magneto-optic effect on the intensity of the field. In case we are dealing with magnetized crystals transparent in the visible region of the spectrum it is possible to transform measurements to the ultraviolet region, so that by reducing the coefficient of absorption the depth of light penetration will be reduced to the required magnitude. Finally, if in addition to this restraint on the depth of penetration of light rays, i. e. there is a limiting constraint on the size of the area from which light is reflected then we can use the magneto-optic method of measuring the characteristics of the micron sized sections of the surface.² The area of illumination can be put under an optical microscope with good resolution of up to $1 \mu^2$, and consequently the size of the "sample" the magnetic characteristics of which we wish to measure is less than 10^{-13} cubic centimeters. We present some examples of the use of this method to solve various physical and applied problems.

A) Surface magnetism of hematite³. Magneto-optic study of the magnetism of low symmetric walls of hematite monocrystals has shown that the character of the magnetic state of the crystal volume and surface layer differ qualitatively. This phenomena is due to the spontaneous formation of a near surface transition domain wall type magnetic layer which in its turn is due to changes in the symmetry of the surrounding surface magnetic ions. The thickness of this transition layer can be changed by an external magnetic field within the range of several microns to zero. Calculations show that the reasons for the origin of the surface magnetism of hematite might be the magnetic dipole interaction of surface magnetic ions, with the stipulation that the "spread" of the transition layer into the crystal takes place through exchange interaction.

B) The formation of a thin ferromagnetic layer on the surface of austenitic steels. Heating non-ferromagnetic austenitic chrome manganese steel (EP-838) (structural steel for the first wall of a thermonuclear reactor) to temperatures of 400-100°C in a high vacuum leads to the formation of a thin (a few microns) surface ferromagnetic layer. This phenomena is explained by the evaporation of the basic alloy of the steel - manganese. No ferromagnetic phase formation was observed in grade SS-316 chrome nickel steel. The appearance of a ferromagnetic layer indicates a gamma-alpha phase transition in the near surface layer. In this case the magneto-optic method can be used for diagnostic purposes.

C) Surface segregation of nickel in ferromagnetic nickel-zircon catalysts.⁵ It has been known that catalytic activity of nickel and zircon

catalysts increases from zero to a maximum in the course of a few hours. Magneto-optic research on the surface of these catalysts has shown that this increased activity involves the formation of a thin ferromagnetic nickel layer located under a surface oxide film. The formation of this sandwich type structure in the surface region was established with the help of magneto-optic scanning of the surface with light of varying wave lengths.

d) Structure of domain walls in ferromagnetic materials.² The study of the magneto-optic properties of small surface sections at resolutions close to limiting ones resulted in reliable registration of signals directly from the output sections of domain walls on the surface of ferromagnetic metals - iron and a weak ferromagnetic material - hematite. It was shown that the structure of domain walls substantially changes as surface is approached; the formation of subdomains inside the domain wall and their changes under the effects of an external magnetic field, and other phenomena were observed.

e) Study of the distribution of magnetization in micron sized elements.⁶ It is understood that magneto-optic methods of micron resolution are suitable not only for studying magnetic properties of various sections of large samples, but also for studying small ferromagnetic elements. The appearance of such elements is due to the needs of modern microelectronics; they are a component part of memory cores of cylindrical magnetic domains, and thin film magnetic heads. The area of utilizing magnetic microelements will constantly increase in the future. The distribution of magnetization in such elements and their magnetic characteristics is completely determined by functional parameters of those devices for which they have been developed. Research on control elements and herringbone detectors of surfaces with cylindrical magnetic domains, and on magnetic circuits of integral magnetic heads has revealed a number of new factors changing the existing ideas and providing material upon which to base theoretical calculations of devices with such elements.

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THERMODYNAMICS OF LIQUIDS BELOW DEBYE TEMPERATURE

In accordance with the concepts developed by Frenkel' a characteristic property of liquids is the greater frequency of atomic vibrations ω near some equilibrium conditions compared to the inverse lifetime τ close to the equilibrium condition. In low temperature quantum ranges in which atomic vibrations are essentially zero order vibrations, and the time τ , is affected by quantum tunnelling the inequality $\omega\tau \gg 1$ indicates that in the liquid there are two characteristic energies of a quantum nature differing in their order of magnitude - Debye temperature Θ and and the indeterminacy of the energy $T_d \hbar \tau$ and this is linked to the delocalization of the particle - and to physically different temperature ranges corresponding to the quantum liquid: 1) $T \ll T_d$; $T_d \ll T < \Theta$. Since the order of magnitude of T_d corresponds with the temperature of quantum degeneracy (Fermi or Bose) It is clear that the first inequality actually only applies to isotopes of helium - ordinary quantum liquids. The number of quantum liquids of the second type is greater (in addition to helium there are also isotopes of hydrogen).

In order for the liquid to solidify at $T \ll \Theta$ it is necessary that the amplitude of zero order vibrations not be too small compared to the distance between particles or, what is the same, the Debye temperature Θ not be too small compared to the characteristic energy of adjacent particle interaction in the liquid U . Actually in helium and hydrogen Θ is always somewhat less than U . Since $\omega\tau$ is proportional to $\exp(U/\Theta)$ this, however, is completely sufficient to ensure the fulfillment of the condition $\omega\tau$ much greater than 1 (or T_d much less than Θ) for the applicability of the Frenkel' picture of the liquid.

It turns out that the thermodynamic properties of quantum liquids in the range $T_d \ll T \ll \Theta$ can be in general explained theoretically. Actually, the condition $T \gg T_d \hbar \tau$ permits, during the calculation of thermodynamic functions, viewing atoms of the liquid as being localized near equilibrium

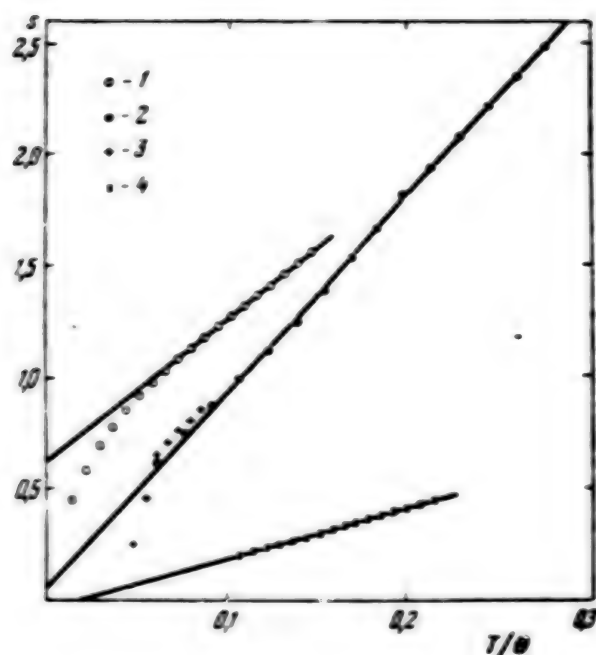
conditions. Since a liquid lacks long term order and the equilibrium condition is quite irregularly distributed in space, the liquid is similar to glass. Since when T is much less than Θ there are practically no vibrations, the main contribution to the thermodynamics is made by a mechanism similar to that suggested by Anderson, Halperin, and Varma³; and by Phillips⁴ to explain the low temperature properties of glass. Specifically this refers to excitations corresponding to the transition of atoms in the neighborhood of the equilibrium condition and increases in energy of the magnitude $c \approx T$. The difference in the case of glass consists in the fact that in the liquids under consideration in view of the large probability of tunnelling all energy barriers are penetrated, since the insignificant concentration of excitations is due only to the insignificant temperature compared to the energy of interaction U . If $U \gg T$ it is probable that a given atom has an adjacent vacant equilibrium condition with an energy of excitation between c and $c+dc$. If $c \ll U$ the density level does not depend upon the energy or upon the order of magnitude equal to z/U where z is the effective number of the adjacent vacant equilibrium conditions. The free energy of the liquid calculated per atom is equal to

$$f(T) = -T \int_0^{\infty} v dc \ln(1 + e^{-\frac{c}{T}}) = -\frac{\pi^2}{12} v T^2$$

from which we find the entropy and heat capacity

$$s(T) = c(T) = \frac{\pi^2}{6} v T$$

The diagram shows the experimental dependency⁵⁻⁷ of the entropy of the liquids He^3 , He^4 and parahydrogen calculated per atom upon the relationship T/Θ . Debye temperature is calculated from the official formula for solids, in which changes in the speed of sound and density of liquid are substituted for the pressures under consideration, i.e. $P = 0$, $P = 25$ atmospheres, $P = 64.6$ atmospheres respectively for He^3 , He^4 and H_2 . Computations result in the values of $\Theta = 13.7^\circ\text{K}$, 32.7° , 155°K . In all cases predicted by formula (1) the linear law is well fulfilled, with the exception of the low temperature ranges for He^3 and He^4 , in which quantum degeneracy begins to appear. It is also important to note that for He^3 the direct extrapolation from the experimental values as $T \rightarrow 0$ is not towards 0 but as it should be towards the value $s \approx 0.62$ close to $\ln 2$, in this case the entropy of the disordered nuclear spin should be added to the entropy determined by formula (1). In comparing the slopes of the lines in the diagram to formula (1) we find a value of the inverse density equal to v^{-1} for He^3 , He^4 and H_2 to be 3.5°K , 6°K and 110°K respectively, this is completely reasonable.



Temperature Dependence of Entropy on Atom

1 - He^3 at pressure of saturated vapors⁵, 2 - He^4 at pressure of 25 atmos.⁶
 3 - He^4 at pressure of 25 atmos.⁵, 4 - Parahydrogen at 64.6 atmos.²

The inequality $T \ll \Theta$ was also substantial in the range of the quantum region $T \ll T_d$. Castaing and Nozieres⁸ in analyzing the magnetic properties of liquid He^3 in a Fermi liquid region, noted that the inequality $T_d \ll \Theta$ makes it possible to view He^3 as a system close to the solid state.^d This explains the relative weakness of exchange interaction of nuclear spins and the related anomalously large magnitude of the magnetic susceptibility. For He^4 in the region of superfluidity the anomalously small density of particles in the Bose Einstein condensate are a phenomena similar to the solid state. In addition the positive dispersion of phonon velocity in HeII observed in the experiment has its natural explanation here. Actually, in accordance with the general considerations of Mandelstam and Leontovich¹⁰ the presence in a liquid of any large relaxation time (in this case τ) causes the dispersion of sound, in which the speed of sound always grows with increasing frequency. A brief summary of the work was published in¹¹.

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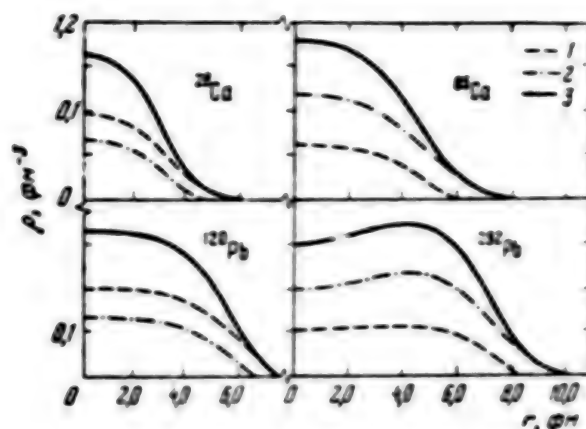
THE STUDY OF NUCLEI FAR FROM BETA STABILITY

In recent years there has been a marked intensification of physicists' interest in nuclei far from beta stability. Several international conferences have been dedicated to the discussion of their properties and the results of experimental research. In spite of the great difficulties of obtaining such nuclei in laboratory conditions, due to their small formation cross-section in nuclear reactions and their short life time, information about their properties is very important both from the perspective of astrophysics, since they are constantly formed in various astrophysical processes (for example the process of "fast" neutron capture during supernova explosions, or the reaction of heavy splitting, fission and fragmentation under the effects of protons and alpha particles with high energies in stellar atmospheres, in the envelopes of supernova and in the interstellar medium), and also for the creation of an adequate theory of the nucleus.

The basic characteristic properties of these nuclei are as follows: 1) an "unusual" ratio between the number of neutrons and protons, 2) an "unusual" relation between Coulomb forces and nuclear forces, 3) a substantial difference between the binding energy of protons and neutrons, 4) different distribution of radii of protons and neutrons leading to the formation of a "loose" halo containing primarily nucleons of one type^{1,2} (figure 1), 5) a large beta decay energy.

The presence of a halo of weakly bound excess nucleons around the core of tightly bound nucleons of both types, in addition to the other characteristics mentioned should lead to differences in the structure of similar nuclides and have an effect on such important characteristics as the type of potential, moment of inertia, form, etc. In order to develop an adequate theory of the nucleus, experimental information on nuclei far from beta stability is at least as important as information on nuclides in this region.

Figure 1



Profile of Distribution of Protons and Neutrons for ^{28}Ca , ^{85}Ca , ^{120}Pb , ^{292}Pb According to Computations in study⁶.

1. Protons. 2. Neutrons. 3. All Nucleons

Works³⁻⁶ have examined some of that expected near the boundaries of nuclide stability (two neutron decay³, "delayed" emission of ^3H and $^3\text{He}^4$). It is shown in⁵ that observations in the laboratory of G. N. Flerov [OJYAI Joint Institute of Nuclear Research = JINI] that the phenomena of "delayed" fission is especially widespread in neutron excess nuclei. This should have an influence on the development of the process of "fast" neutron capture (r-process) and on the distribution of the elements. Studies of the r-process with a view to the influence of nucleon shells have shown that they are extended considerably further than would follow from classical estimations, and for some values of parameters can lead to the formation of super heavy elements.

Works⁹⁻¹⁰ examined the characteristics of effects strongly dependent upon energy (double beta decay⁹, the contribution of higher series to single beta transitions¹⁰ with large decay energies). At the present time in various nations there are an entire series of systems in operation which are intended to study such "far" nuclides obtained at accelerators of protons and heavy ions, and also from reactors. In the USSR the study of such nuclei is being conducted at the heavy ion accelerator at the laboratory of G. N. Flerov at the JINI.

For the past several years at the Leningrad Institute of Nuclear Physics imeni B. P. Konstantinov of the USSR AN has obtained nuclides with half-lives

up to ten seconds in reactions initiated by protons accelerated by the synchrocyclotron to energies of one GeV. After rapid separation from a boiling liquid target by blowing through hydrogen and transformation to volatile oxides, these nuclides are transferred to a soundproof chamber with the help of a pneumatic shuttle. New short-lived isotopes of osmium and rhenium^{11,12} were first obtained by this method. In the case of rhenium it was possible to move from the lightest stable isotope ^{185}Re by 15 units of mass (^{170}Re , $T_{1/2} = 9 \pm 2$ seconds).

At the end of 1975 the IRIS complex was put into service at the LIYAF [Leningrad Institute of Nuclear Physics]. In this system a mass separator works "on line" with the synchrocyclotron. The study of nuclide emission is continuous as they are formed and transported in the form of accelerated ions to a collector behind a radiation detector. A block scheme of the IRIS complex is shown in figure 2. The gamma spectra of xenon (^{118}Xe , ^{119}Xe) were studied with the help of this system.

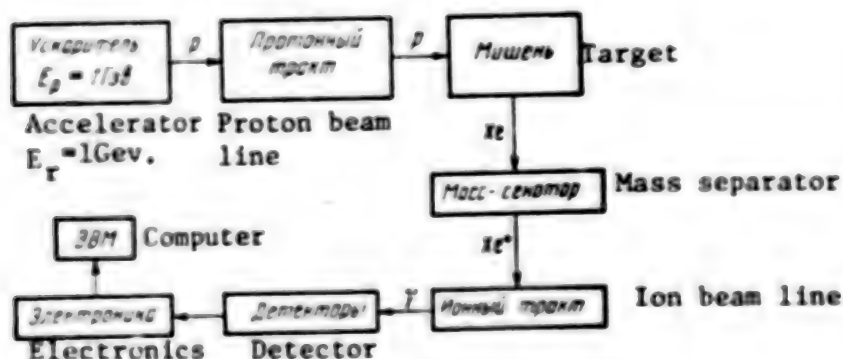


Figure 2. Block Diagram of IRIS Complex

The combination of the efforts of the LINF group and the department of nuclear spectroscopy and radiochemistry of the Nuclear Problems Laboratory at JINI was very efficient. Using an ion source with surface ionization developed by JINI combined into a single element with a target irradiated by protons and suited for work with a mass separator in the IRIS system, the alpha decay of 27 isotopes of rare earth elements was studied.¹⁴ Usually alpha decay of isotopes obtained in nuclear reactions is studied without a mass separator and alpha radiation is identified by function of excitation, i.e. the graph of the dependency of the output of various types of isotopes upon the energy. Uncertainties and errors frequently arise with such a method. Some of these errors were found in the studies mentioned¹⁴: for example, the proper identification of the energy of the alpha line of the isotope ^{156}Yb revealed by the new isotope of ^{157}Lu and its basic characteristics were studied - energy of the alpha line, relative intensity of the alpha decay branch and the half-life ($T_{1/2} = 5.2 \pm 0.3$ seconds). This isotope is separated from the lightest stable isotope of lutecium by 18 mass units.

There are now two ion beams operating at the IRIS system and it is planned to include a third. This will make it possible to simultaneously conduct experiments with three selected isotopes of an element. In addition to the JINI group, workers from LGU [Leningrad State University], Tam AU [Tambov State University], and the Radiev Institute have been included in this work. It is further planned to expand the circle of participants to other institutions in the nation and foreign nations.

A methodology for the precise measurement of the mass of nuclides far from beta stability is being prepared (jointly with a group at the Radiev Institute) using a high resolution mass spectrometer developed by Z. M. Kel'man. This will be used to study the charge radius of nuclei with respect to the isotropic shift of optical lines with the help of lasers with adjustable wave length, and to determine the spins of magnetic and quadrupole moments (jointly with the group of V. S. Letokhov at ISAN) and the wide aperture crystal defraction spectrometer developed by O. I. Sumbayev's group and LINF makes it possible to study shifts in the optical lines and the effects of ultrafine interaction.

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UDC(539.144+621.378.325) (048)

DETECTING OF SINGLE ATOMS AND NUCLEI BY THE METHODS OF LASER SPECTROSCOPY

In recent years considerable attention has been given to the development of methods of laser detection of very small, or as is said trace quantities of elements (see the survey¹). In theory the limit of detection is a single atom, since it has complete spectral information on its structure. Therefore one of the basic goals of laser spectroscopy is the development of methods for detecting single atoms. The most promising is the method of laser excitation of resonance fluorescence, resulting in the maximum number of photons scattered by one atom, and the method of selective multistage ionization by laser irradiation permitting the ionization of practically every atom. Both methods were recently successfully demonstrated at the Institute of Spectroscopy of the USSR AN [Academy of Sciences].

The feature of the resonance fluorescence method is that the same atom can repeatedly interact with laser radiation and re-radiate from all sides photons of the same frequency as the excitation frequency. If the intensity of laser radiation is greater than the intensity of resonance transition saturation, the population of the ground and excited states will be equivalent. In this case during the time of light ray intersection T the atom re-radiates $N_{\text{max}} = T/2\tau_{\text{spont}}$ photons, where τ_{spont} is the time of spontaneous decay of the excited state into the ground state.

For example, in the experiment Na atoms were subjected to continuous laser light from a dye laser, the frequency of which was tuned to the resonance D_2 line. On 4 mm path ways each atom re-radiates in 4π sr about 200 photons.² This fluorescence signal was detected by two photomultipliers. A two channel registration system working in a coincidence mode was used to distinguish the fluorescence signal from each atom encountering a light ray. The minimum detectable flux of Na atoms was 10 atoms per second, this corresponds to an average atomic density of 10^{-4} in the registration region. Unfortunately, the fluorescence method for detecting single atoms is unsuitable for the majority of complex atoms having metastable states close to the ground state, since the cyclic nature of the process is easily interrupted after the transition of the atom from an excited to a metastable state. In this case the photo-ionization method is more successful and universal.

Such an approach to detecting single atoms is based on a method of their selective multistage photo-ionization suggested by the author of the report both to separate isotopes and to detect atoms back in 1969 (see the survey⁴). If the detection is carried out in a vacuum or a low pressure gas (the most interesting case from the point of view of maximum spectral resolution), then the ionization of each atom in the laser light requires laser impulses with a frequency sequence of about 50 kHz (with a thermal velocity of $5 \cdot 10^4$ cm/second and an interaction path of 1 cm). With an average power of the tunable laser radiation attainable in laboratory conditions on the order of 1 watt, the majority of the atoms can be effectively ionized only if they are ionized through a high Rydberg state. In this method of selective ionization which was also suggested and studied at the Institute of Spectroscopy USSR AN⁵, the process of nonresonance photo-ionization of atoms in a transition from an intermediate state to a continuum is replaced by a process of resonance excitation of atoms from one state to a higher state near the ionization boundary with subsequent ionization by an electrical field impulse. The efficiency of ionization in this process is close to unity. Since the excitation at all subsequent stages is resonance, and the saturation of all transitions requires comparatively low density of laser impulses ($10^{-4} - 10^{-6}$ K/cm²) which is easily attainable with the help of existing impulse dye lasers. This was successfully demonstrated in experiments on the detection of single Na atoms³ (two stage laser excitation + ionization by an electrical field) and Yb (three stage laser excitation + ionization by an electrical field).

Attention should be directed to the fact that by using isotopic or isomeric shifts at all subsequent transitions, multistage laser excitation can also be used to obtain extremely high selectivity in atom detection (see the figure). Ordinary selectivity of excitation at one stage is limited by the unavoidable over-lapping of excitation on the Lorentz side-band of the neighboring line. In better cases, where the natural width of the line Γ and the distance between them $\delta\omega_1$, the limiting selectivity is $S_1 = (2\delta\omega_1/\Gamma)^2 \approx 10^5 - 10^6$. However in three state selective excitation it can be increased to $S = S_1 \cdot S_2 \cdot S_3 \approx 10^{15} - 10^{18}$. This is of fundamental importance for detecting rare isotopes, isomers of forms of nuclei, superdense nuclei, etc.

The high sensitivity and resolving power of the methods of laser spectroscopy permits research on the characteristics of the nuclei available in very small quantities. This possibility is based on the fact that many characteristics of the nucleus manifest themselves in a completely identical manner in the fine ranges of the optical spectrum. These are: the number of protons and neutrons, the spin and quadrupole moment of the nucleus and the forms bound to it, the average radius and excitation of the nucleus

and even its velocity and orientation. This is the key to using methods of laser spectroscopy in nuclear physical experiments where work with nuclei having the necessary characteristics is conducted through subjecting them to the effects of coherent light on the electron cloud surrounding the nucleus.

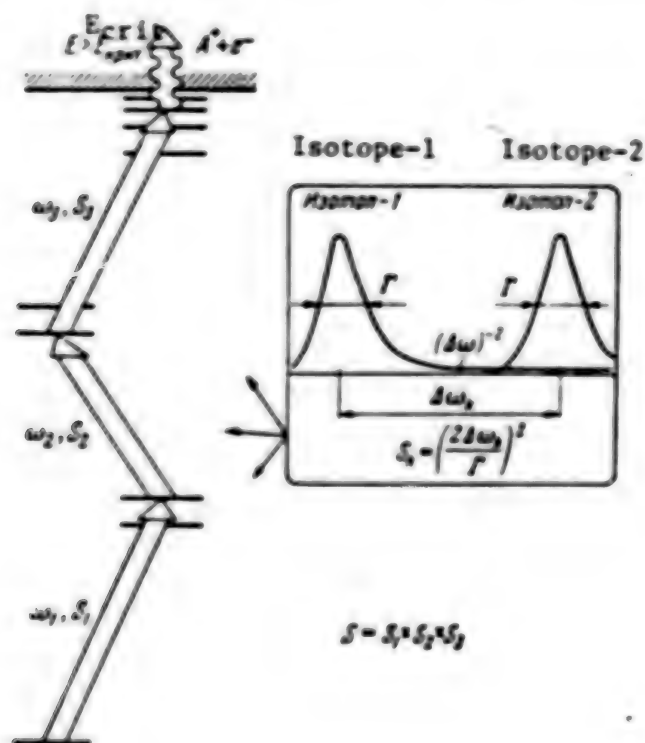


Figure 1. System of Highly Selective Three Stage Excitation of the Rydberg State of Atoms Near the Ionization Boundary with Subsequent Ionization by Electrical Field Impulse, Overcoming the Constraints of Ionization Selectivity due to the Overlapping of Side Bands Near the Absorption Line.

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Izdatel'stva "Nauka", "Uspekhi fizicheskikh nauk", 1979

11,574
CSO: 1870

BRIEFS

SMALL INDUSTRIAL LASER—The Department of Physics of the Riga Polytechnical Institute has developed a miniature electronic device which makes it possible for some thousandths part of a second to direct a laser beam in any direction and to focus it at the required distance. The Latvian scientists used powerful infrared lasers in laboratory experiments. As results have shown, the proposed method makes possible efficient processing of various materials. Specialists in the radio engineering, furniture and several other industries of the republic have shown interest in the new device. [Excerpt] [Riga SOVETSKAYA LATVIYA in Russian 7 Sep 79 p 2] 12-350

CSO: 1862

USSR

UDC 621.315.592

OPTICAL ABSORPTION AND ANNIHILATION OF POSITRONS IN ELECTRON-IRRADIATED GaAs

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 13 No 6, 1979
pp 1142-1145 manuscript received 31 Jul 78; after editing 25 Dec 78

AREF'YEV, K. P., BRUDNYY, V. N., BUDNITSKIY, D. L., VOROB'YEV, S. A. and
TSOY, A. A., Scientific Research Institute of Nuclear Physics at Tomsk Poly-
technic Institute imeni Kirov; Siberian Physico-Technical Institute imeni
V. D. Kuznetsov at Tomsk State University

[Abstract] Despite the considerable number of studies dealing with radiation defects (RD) in GaAs crystals, virtually nothing has previously been known about their nature, owing to difficulties in using direct methods (EPR) of investigating the structure of these defects. Hence the 2γ positron annihilation method, which is sensitive to deep defect states in the forbidden band of the material, was used along with measurement of the spectra of optical absorption in the region $0.5\frac{h}{4E_g}$ to investigate RD in GaAs crystals irradiated at $T \sim 300$ K with electrons (2 Mev) in a Van de Graaf accelerator. Analysis of the absorption spectra of the irradiated specimens revealed that the dominant concentration of defects in GaAs pertains to deep 1.0 eV defects, of a nature which analysis of the correlation curves of 2γ positron annihilation showed to be in the nature of a vacancy, presumably \sqrt{Ga} . Figures 5; references 14: 6 Russian, 8 Western.
[166-1386]

USSR

UDC 621.315.592

INVESTIGATION OF THE CONDUCTIVITY OF SILICON WITH SUPERCONDUCTING CONTACTS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 13 No 6, 1979
pp 1189-1192 manuscript received 23 Jun 78; after editing 24 Nov 78

KRIVKO, N. I., Moscow Institute of Electronic Engineering

[Abstract] The conductivity of silicon was investigated as a function of magnetic and electrical fields as well as of temperature in relation to n-type and p-type. One side of the specimens was coated with lead or tin films and the other, with aluminum electrodes. Altogether about 100 specimens with lead contacts and 10 with tin contacts were investigated. Carriers with a $10^{13}-10^{14} \text{ cm}^{-3}$ at helium temperatures were induced by illuminating the electrodes with a laser beam (wavelength 633 nm), with corresponding filters. For silicon directly adjoining the metal or connected to it via a dielectric, the relationship of conductivity to magnetic and electrical fields and temperature hinges on whether the metal is in the normal or superconducting state.

Correlation with superconducting properties always occurs in the case of photocurrent but is less frequent in the case of dark current. In the region of transition of the metal to the normal state the voltage in the system changes abruptly regardless of the cause of the transition--critical voltage, critical temperature, or critical magnetic field. The pattern of photocurrent dependence upon simultaneous action of two factors--magnetic field and temperature, magnetic field and current across the semiconductor, temperature and current--is in good agreement with the pattern of film resistance. Figures 2; references 6: 3 Russian, 3 Western.
[166-1386]

USSR

UDC 621.315.592

INVESTIGATION OF THE OPTICAL PROPERTIES OF THE ACTIVE SURFACE OF CdS BY MEANS OF INEQUILIBRIUM REFLECTION SPECTROSCOPY

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 13 No 6, 1979
pp 1206-1208 manuscript received 2 Jan 79

STERLIGOV, V. A., KOLBASOV, G. YA., BORTSOV, V. B., the late TYAGAY, V. A., LENGAUER, YE. S. and FILIPPOV, V. M., Kiev, Institute of Semiconductors, UkrSSR Academy of Sciences

[Abstract] The spectra of exciton reflection of CdS were investigated in the presence of high excitation levels. The experiments were conducted on CdS plates ($d=30\text{ }\mu\text{m}$) with a natural surface exceeding at $T = 77\text{ K}$ the critical condensation temperature on the phase diagram of strongly excited CdS; the pumping was accomplished with the aid of focused light from a pulsed N_2 -laser. It is concluded that the pair concentration in the neighborhood of the CdS surface markedly exceeds the critical value even in the presence of weak one-photon pumping and hence that excitons are absent in the active subsurface region. A relationship between the Mott transition and the lasing threshold is established. The possibility of the amplification of light on its external reflection from the semiconductor's surface is verified. Figures 2; references 12: 6 Russian, 6 Western.
[166-1386]

USSR

NONMONOTONIC UNWINDING OF THE HELIX IN CHOLESTERIC LIQUID CRYSTALS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 30 No 2, 20 Jul 79 pp 111-114 manuscript received 23 May 79

BELYAYEV, S. V. and BLINOV, I. M., Scientific Research Institute of Organic Semiconductors and Dyes

[Abstract] The application of an electrical field at right angles to the helix axis in cholesteric liquid crystals (CLC) with positive dielectric anisotropy ($\Delta\epsilon > 0$) causes unwinding of the helix, i.e., increase in the spacing (pitch) between the turns of the helix. Experiments with a nematiccholesteric mixture of azoxy compounds with cynaophenyl ester and cholesteryloleyicarbo-nate placed into a sandwich cell consisting of two glass plates whose internal surfaces were covered with a dielectric coating assuring parallel orientation of CLC molecules to these surfaces, demonstrate that this unwinding is a non-monotonic function of the intensity of the electrical field in the CLC layer enclosed between the two surfaces. On disconnection of the current field the unwinding is accompanied by the formation of spatially modulated structures. Figures 3; references 9: 2 Russian, 7 Western.
[161-1386]

USSR

UDC 621.315.592

RADIATIVE RECOMBINATION IN UNDOPED SOLID SOLUTION OF $\text{GaAs}_{1-x}\text{Sb}_x$ ($0 < x < 0.3$)

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 13 No 6, 1979
pp 1235-1238 manuscript received 12 Feb 79

BIRYULIN, YU. P., ICHKITIDZE, R. R., KRIGEL', V. G. and SHMARTSEV, YU. V.,
Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences,
Leningrad

[Abstract] The development of optoelectronics and particularly of light-wave communications poses new needs for the development of effective emitters and receivers in the near IR range of 0.9-1.1 μm . From this standpoint, solid solutions of $\text{GaAs}_{1-x}\text{Sb}_x$ ($0 < x < 0.3$) are of interest. In this connection, the photoluminescence of epitaxial films of a specially undoped solid solution of this kind was investigated at 300, 77, and 4.2 K. The excitation was accomplished by means of a helium-neon laser (632.8 nm) and the radiative recombination was recorded with the aid of an uncooled FEU-62 photomultiplier or an FD8C germanium photodiode. The photoluminescence spectra revealed a second, longwave band in the specimens with $x < 0.05$ and $x > 0.2$, which was not present in the specimens within the intervening range of solid solution compositions: this points to the appearance of a new recombination center that is apparently due to structural defects in the solid solutions. A formula for the $I_p(x)$ dependence of the solid solutions at 77-300 K is derived from the experimental findings. Figures 3; references 13: 6 Russian, 7 Western.
[166-1386]

USSR

EFFECT OF ELECTRON BOMBARDMENT ON THE THERMOPHYSICAL AND THE ELECTROPHYSICAL PROPERTIES OF n-InAs

Yerevan IZVESTIYA AKADEMII NAUK ARMJANSKOY SSR in Russian Vol 14 No 2, 1979
pp 134-137 manuscript received 14 Jul 78

AMATUNI, K. M., AYRAPETYAN, S. A., NIKOGOSYAN, S. K. and SAAKYAN, V. A.,
Yerevan Institute of Physics and Yerevan State University

[Abstract] In a study of the n-InAs semiconductor, the temperature dependence of its thermal and electrical conductivities as well as of the thermal emf was measured: first before and then after γ -bombardment with fast electrons at either room temperature or near the liquid-nitrogen temperature. The initial concentration of free electrons in the specimens varied from $4 \cdot 10^{15}$ to $1 \cdot 10^{19} \text{ cm}^{-3}$. Bombardment with low-energy electrons (7.5 MeV) was found to

have produced point defects, with the rise of the concentration of free electrons being due to impurities (Cu,S) as well as intrinsic defects. Bombardment with high-energy electrons (50 MeV) could have possibly produced also regions of disordering, but small enough to play a very insignificant role. Figures 3; references 8: 3 Russian, 5 Western.
[159-2415]

USSR

FOURTH ALL-UNION CONFERENCE ON RADIATION PHYSICS AND THE CHEMISTRY OF IONIC CRYSTALS

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR in Russian No 2, Feb 79 pp 143-145

SHVARTS, K.

[Abstract] Three hundred individuals representing more than 50 scientific institutions in the USSR participated in the conference, held in Riga on 3-5 Oct 79, and organized by the councils of the Academy of Sciences on high energy chemistry and the radiation physics of solids. There were 28 survey reports on radiation defects, radiolysis, and effects of large doses. The 150 reports presented at the 8 sections were summarized and published prior to the conference [Riga, "Chetvertoye Vsesoyuznoye soveshchaniye po radiatsionnoy fizike i khimii ionnykh kristallov," Abstracts of the Reports, 1978, 510 pp]. About 14 reports are summarized here, including: Characteristics of high temperature radiolysis of alkali halide crystals (2 reports); the mechanisms of the formation of radiation defects; a closed system of equations describing the diffusion of point defects in solids; kinetics of the formation of secondary excited luminescence centers; radiation effects of powerful nanosecond pulses (a new type of conductivity in semiconductors and dielectrics was discovered); effects of ultrasoft X rays; use of electron exoemission to study radiation effects. Research should be expanded on the theory of radiation defects, especially pulses in the picosecond range and two-photon excitation. References 2: 1 Russian, 1 Western.

ON THE NATURE OF COLORING OF NATURAL AND SYNTHETIC SAPPHIRES, AND AN EXPERT METHOD OF IDENTIFYING THEM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 246, No 3, 21 May 79
pp 599-601 manuscript received 14 Feb 79

GRANADCHIKOVA, B. G., NIKOL'SKAYA, L. V. and SAMOYLOVICH, M. I., All-Union Scientific Research Institute of Synthesis of Mineral Raw Material, Aleksandrov, Vladimirskaya Oblast

[Abstract] The optical absorption spectra of synthetic and natural diamonds are compared as a basis for identifying synthetic analogs of natural sapphires with given color characteristics. The absorption spectra of faceted stones were recorded on an SF-18 spectrophotometer in polarized light at wavelengths of 400-750 nm. Fifty specimens of natural and synthetic sapphire were studied with colors of azure, indigo and green. The analysis also includes data from other sources on optical absorption of sapphires at wavelengths ranging from 200 to 1400 nm. The artificial stones show considerable differences in spectra from the natural stones. The most distinctive feature of the absorption spectrum of artificial azure and indigo sapphires is the absence of the band at 450 nm, which is observed in the natural stones. The absorption spectrum of synthetic green sapphires shows absorption on 417 nm that is missing in the natural gem, and is lacking a bank in the vicinity of 450 nm that can be seen in the spectrum of the natural green sapphire. The proposed spectrophotometric method provides a reliable way to distinguish natural stones from synthetic. Figures 2; references 2 Russian.

[143-6610]

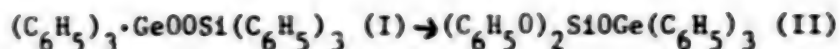
CRYSTAL STRUCTURE OF TRIPHENYL(TRIPHENYLGGERMYLPEROXY) SILANE $(C_6H_5)_3GeOOSi(C_6H_5)_3$

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 246, No 3, 21 May 79
pp 601-605 manuscript received 17 Jan 79

LEBEDEV, V. A., DROZDOV, YU. N., KUZ'MIN, E. A., GANYUSHKIN, A. V., YABLOKOV, V. A., and BELOV, N. V., Academician, Gor'kiy Physicotechnical Research Institute, Gor'kiy State University imeni N. I. Lobachevskiy

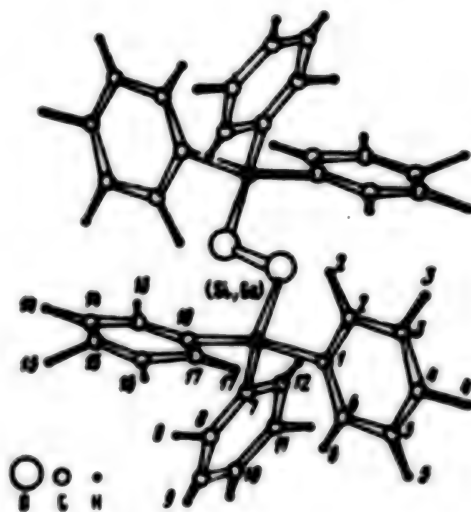
[Abstract] Peroxide derivatives of silicon are of interest because of the possibility of using them as initiators of free-radical processes. Of considerable theoretical interest is the question of participation of vacant d-orbitals of the silicon atom in different kinds of interactions in both

the ground state and the activated state of the molecule. For example the possibility of existence of intramolecular coordination is confirmed by the transformation



with heating. A complete x-ray study is done on peroxide I to determine its structure. The results of analysis show two mutually opposed orientations of molecules in the single crystal with equal probability, leading to a center of inversion in an averaged elementary cell. The structure of the average molecule of $(\text{C}_6\text{H}_5)_3\text{GeOOSi}(\text{C}_6\text{H}_5)_3$ is shown in the figure. The paper contains tables summarizing interatomic distances and valence angles, and also the shortest interatomic distances. Figure 1; references 9.

[143-6610]



USSR

UDC: 546.64+548.55

REGION OF MONOPHASE CRYSTALLIZATION OF NEODYMIUM-ALUMINUM ORTHOBORATE IN A MOLYBDATE MELT SOLUTION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 246, No 3, 21 May 79
pp 613-615 manuscript received 12 Feb 79

TIMCHENKO, T. I., LEONYUK, N. I., PASHKOVA, A. V. and ZHURAVLEVA, O. L.,
Moscow State University imeni M. V. Lomonosov

[Abstract] The conventional solvent for crystallization of rare earth-aluminum borates from a solution in a melt is $\text{K}_2\text{Mo}_3\text{O}_{10}$. However, crystals

of aluminum borates and rare earth elements of the cerium group have not been produced from such a melt solution. This difficulty is circumvented in the case of $\text{NdAl}_3[\text{BO}_3]_4$ by adding an excess of boron and neodymium oxides, enabling investigation of the conditions of formation of this orthoborate in the system $\text{NdAl}_3[\text{BO}_3]_4\text{-B}_2\text{O}_3\text{-Nd}_2\text{O}_3\text{-K}_2\text{Mo}_3\text{O}_{10}$. A method is proposed for determining the region where only solid-phase $\text{NdAl}_3[\text{BO}_3]_4$ is in equilibrium with the melt solution, i. e. the monophasic region of crystallization, without information on the phase diagram of the $\text{Nd}_2\text{O}_3\text{-Al}_2\text{O}_3\text{-B}_2\text{O}_3\text{-K}_2\text{O-MoO}_3$ system. It was found that an increase in the percentage of Nd_2O_3 leads to replacement of $\text{NdAl}_3[\text{BO}_3]_4$ by a phase with high neodymium content--neodymium orthoborate NdBO_3 . A melt enriched with B_2O_3 shows considerable polymerization of boron-oxygen radicals, resulting in formation of dimetaborate $\text{NdAl}_2[\text{B}_4\text{O}_{10}]_0.5$ in exchange for NdAl -orthoborate with isolated BO_3 groups. Small concentrations of boron and neodymium oxides lead to precipitation of an aluminum-rich phase-- $\text{Al}_5[\text{BO}_3]_6$, also containing isolated BO_3 triangles. Experiments on growing $\text{NdAl}_3[\text{BO}_3]_4$ crystals by spontaneous crystallization and by seeding showed similar behavior of these formation with temperature and composition changes. The results enable growth of crystals of this borate in a wide temperature range. Crystals with volume up to 2 cc have been grown. Figure 1; references 7 Russian.

[143-6610]

USSR

UDC: 537.529:621.382.015.5:535.376

LIGHT-EMITTING PROPERTIES OF THE SECONDARY BREAKDOWN REGION AND THE PROCESS OF FORMATION OF MESOPLASMA IN SILICON p-n JUNCTIONS

Riga IZVESTIYA AKADEMII NAUK LATBIYSKOY SSR. SERIYA FIZICHESKIY I TEKH-NICHESKIKH NAUK in Russian No 2, 1979 pp 29-38 manuscript received 30 Jun 78

BALODIS, YA. K. and PURITIS, T. YA., Power Engineering Physics Institute, Academy of Sciences LatvSSR

[Abstract] An investigation is made of the integral radiation from local regions of a mesoplasma in the pulse bias mode for p-n junction of 400-500 μm based on a material with resistivity ranging from 0.4 to 15 $\Omega\cdot\text{cm}$ at ambient temperatures from room level up to 320°C. The experimental facility enabled simultaneous observation of inverse voltage (current) pulses and emission pulses. Thus it was possible to determine the instant of beginning of formation of the secondary breakdown region, and to localize the initial region of formation, and its subsequent expansion. Avalanche p-n junctions with a guard ring were studied, made from p-type material by phosphorus diffusion. A detailed examination is made of emission pulse shape, the dimensions of the mesoplasma, rate of expansion, and spatial distribution of emission. It was found that as the resistivity of the

initial material increases, there is a reduction in the dimensions of the secondary breakdown region at the end of the pulse, whereas the dimensions of the initial region of formation increase. A rise in ambient temperature also increases the size of the initial region of formation. The spatial and time distribution of the emission pulses can be qualitatively explained by the plasmon mechanism for secondary breakdown. Figures 7; references 13: 7 Russian, 6 Western.

[104-6610]

USSR

UDC: 621.317.799;621.382

MICROWAVE REFLECTION FROM A p-n STRUCTURE

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR. SERIYA FIZICHESKIKH I TEKH-NICHESKIKH NAUK in Russian No 2, 1979 pp 43-46 manuscript received 13 Jul 78

ABOLTIN'SH, E. E. and LARIONOVA, N. F., Riga Red Banner Institute of Civil Aviation Engineers imeni the Lenin Komsomol

[Abstract] Previous research has demonstrated the anisotropic nature of scattering of microwaves by semiconductor structures when they pass an alternating electric signal. In this paper the authors analyze the nature of an electromagnetic wave reflected from such a structure when the standing wave is made up of a wave with certain polarization incident on the specimen, and the waves that arise as a result of anisotropic scattering. Various germanium and silicon diodes with cases transparent to microwaves were studied as p-n structures. A microwave signal in the 3-cm band was transmitted through a coaxial cable to a rectangular waveguide with excitation of H_{10} waves. A smooth adapter connected the rectangular waveguide to a circular waveguide terminating in a waveguide measurement line that could be rotated about the axis parallel to the direction of wave propagation. The signal level in this line was monitored by a measurement amplifier. The diode specimen was placed at the end of the measurement line in a holder that fixed the position of the diode relative to the waveguide cross section, while permitting rotation about the axis of the measurement line. A low-frequency electric signal was incident on the diode from an a-f oscillator. This arrangement enabled analysis of the standing wave induced only by excess charge carriers localized in the layer of the p-n junction. It was found that microwaves are anisotropically reflected from a semiconductor diode passing alternating current. The complex reflected wave can be represented as a superposition of several waves of simpler structure that differ in amplitude, phase and frequency. Rotation of the semiconductor diode about the axis coinciding with the direction of wave propagation rotates the plane of polarization of the electromagnetic wave. Figures 4; references 2 Russian.

[104-6610]

USSR

UDC: 537.226:535.21

EVALUATING THE MAGNITUDE OF THE LIGHT-INDUCED CHANGE IN THE INDEX OF REFRACTION OF A VIBRONIC FERROELECTRIC

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR. SERIYA FIZICHESKIKH I TEKH-NICHESKIKH NAUK in Russian No 2, 1979 pp 119-121 manuscript received 31 Oct 78

GULBIS, A. V. and KRISTOFEL', N. N., Institute of Physics, Academy of Sciences LatvSSR, Institute of Physics, Academy of Sciences EstSSR

[Abstract] An examination is made of the photorefractive effect due to photoexcitation of electrons from the valance band to the conduction band in a ferroelectric. It is shown that for parameters of the vibronic theory that characterize wide-gap ferroelectrics of the BaTiO₃ type, the changes in birefringence induced by light correspond to reasonable values of the light-induced charge carriers. The estimated steady-state photorefractive effect applies to the central part of the illuminated region. Generally speaking, in the case of localized illumination of a crystal a certain distribution of changes in birefringence arises along the optical axis. The mechanism of photorefraction considered here is associated with transient screening currents. If the crystal also shows a steady-state photovoltaic effect, the resultant field will make an additional electro-optical contribution to the photorefractive effect. References 15: 9 Russian, 6 Western.

[104-6610]

USSR

UDC: 537.533:535.212

EMISSION OF 'HOT' ELECTRONS AND THE MANY-QUANTUM PHOTOELECTRIC EFFECT WHEN METALS ARE EXPOSED TO LASER RADIATION

Tashkent IZVESTIYA AKADEMII NAUK UzSSR, SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 2, 1979 pp 57-59 manuscript received 31 May 78

ZINOV'YEV, A. V., LUGOVSKOY, V. B. and PAVLICHENKO, M. K., Institute of Electronics imeni U. A. Arifov, Academy of Sciences UzSSR

[Abstract] Previous research done on the emission of "hot" electrons from metals exposed to laser radiation has shown that such emission is apparently due to nonequilibrium excitation of the metal electrons by the laser radiation. In this paper the authors consider the problem of the behavior of the electron gas of a metal interacting with powerful laser radiation having a given quantum energy. It is theoretically shown that laser exposure may lead to emission of "hot" electrons or to the many-quantum photoelectric effect depending on the state of the surface. Experiments are done that

demonstrate the effect of many-quantum photoemission. This is achieved by sputtering a sodium coating on the surface of copper and tungsten targets, thus altering the electronic and optical properties of the metal in the region of radiation absorption. References 4: 3 Russian, 1 Western.

[151-6610]

USSR

UDC: 681.382.3

A NEW TYPE OF PHOTOELECTRETS: ANOMALOUS-PHOTOVOLTAGE FILMS OF CADMIUM TELLURIDE (CdTe:Ag)

Tashkent IZVESTIYA AKADEMII NAUK UzSSR, SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 2, 1979 pp 60-62 manuscript received 23 Nov 77

ERGASHEV, D. E., Fergan State Pedagogical Institute imeni Ulugbek

[Abstract] The paper gives some results of a study of the kinetics of the photoelectret state of anomalous-photovoltage films of silver-activated cadmium telluride. Exposure of these electrets produces photopolarization. It is shown that the polarizing field arises as a result of the intrinsic field of micro-pn junctions. The reciprocity law is satisfied in the new type of photoelectret, i. e. the charge at any instant is determined by the product of light intensity and polarization time rather than by either factor alone. The relaxation of anomalous photovoltage in these films is measured in hours, and conforms to Adirovich's theor [E. E. Adirovich, "Fizika i tekhnika poluprovodnikov," Vol 4, No 4, 1970, p 745]. The photoelectret voltage (residual anomalous photovoltage) is of the order of 100 V or more. Figures 2; references 7 Russian.

[151-6610]

ELECTRICAL CONDUCTIVITY OF CeO_2 AND TiO_2 IN A GAS MIXTURE OF $\text{O}_2 + \text{CO}_2 + \text{SO}_2$

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 246, No 3, 21 May 79
pp 596-598 manuscript received 16 Jan 79

SUNTSOV, N. V., ARKHAROV, V. I., Academician, Academy of Sciences UkrSSR,
KONEV, V. N., MILOSLAVSKIY, A. G. and ZHURAVLEV, N. L., Donetsk State
University

[Abstract] It is shown on the example of n-type CeO_2 and TiO_2 that the very same impurity can show both donor and acceptor properties in non-stoichiometric semiconductor compounds in which anion vacancies are predominant in the defect structure. Electrical conductivity was measured by a four-probe technique on sintered specimens made by the method of cold pressing from finely dispersed pure oxide powders. Sulfur doping was done from the gas phase. Curves for conductivity as a function of the partial pressure of O_2 in the gas mixture show that singly ionized oxygen vacancies predominate in CeO_2 , while doubly ionized oxygen vacancies predominate in TiO_2 . Sulfur has no effect on electrical conductivity when the logarithm of the partial pressure of oxygen is equal to a certain temperature-dependent parameter m . When the logarithm of the partial pressure of oxygen P_{O_2} exceeds m , sulfur doping increases the electrical conductivity of the specimens. Under these conditions the concentration of oxygen vacancies is relatively low, and a sulfur ion at an oxygen site in the lattice may show donor properties due to lower electroegativity. A reduction of P_{O_2} in the gas phase increases the concentration of anion vacancies in the crystal, and at $\lg P_{\text{O}_2} < m$ sulfur doping of the oxides reduces electrical conductivity. Curves are given showing the temperature dependence of m , and also showing the square of the relative change in electrical conductivity as a function of the partial pressure of SO_2 for different P_{O_2} . Figures 3; references 2 Russian.

[143-6610]

USSR

SPONTANEOUS MAGNETIC FIELDS WITH DIPOLE CONFIGURATION IN A LASER PLASMA

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 29 No 11, 5 Jun 79 pp 700-705 manuscript received 17 Apr 79

KOROBKIN, V. V. and MOTYLEV, S. L., Physics Institute imeni P. N. Lebedev,
USSR Academy of Sciences

[Abstract] Spontaneous magnetic fields (SMF) arise owing to the non-parallel (axial asymmetry) nature of the gradients n and T arising in the focal spot region of the plasma during the action of laser radiation. It is surmised that a commensurate disturbance in the toroidally symmetric distribution of closed currents in the focal spot should result in the formation of an "uncompensated" current loop and the formation of a magnetic moment whose field can also be recorded outside the plasma. And indeed such a moment has been recorded in an experimental setup on inducing asymmetric conditions of laser radiation by three different techniques: 1) use of a target consisting of two dielectrics with differing densities; 2) beaming the laser radiation at an angle onto a homogeneous planar target; and 3) shifting the beam away from the center of the target. In all three cases the generative mechanism of the magnetic moment is believed to be the same and associated with the disturbance of axial symmetry of the distribution of n and T gradients in laser plasma which results in distorting the toroidally symmetric configuration of closed currents and the formation of an "uncompensated" current loop causing dipole radiation. Figures 3; references 17: 4 Russian, 13 Western.
[163-1386]

USSR

ON THE POSSIBILITY OF ENHANCING THE NEGATIVE SUSCEPTIBILITY OF PYROCARBON

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 29 No 12, 20 Jun 79 pp 784-786 manuscript received 20 Apr 79; after editing 11 May 79

BRANDT, N. B., KOTOSONOV, A. S., KUVSHINNIKOV, S. V. and SEMENOV, M. V.,
Moscow State University imeni M. V. Lomonosov

[Abstract] The search for substances with considerable diamagnetism that persists over a broad range of magnetic fields and temperatures is of major practical interest in connection with the development of devices utilizing the magnetic levitation method. In this connection, a number of specimens of film pyrocarbon specimens deposited at various temperatures was investigated by a modulation method to determine their differential susceptibility and magnetoresistive properties in magnetic fields of up to about 6.4 kA/m and at temperatures of from 2 to 300 K. Diamagnetism was found to increase

with decrease in hole concentration, which indicates that filled bands are a major factor in susceptibility. The magnitude of susceptibility was found to increase linearly to a rough approximation, with increase in magnetic field intensity. The maximum magnetic susceptibility recorded for the pyrocarbon specimens was $\sim 0.2\%$ of $-1/4\pi$ which is about twice as high as for single crystal graphite at low temperatures (or 1.5 times as high at room temperature). This maximum is higher than for any other known substance except superconductors. It appears that a further decrease in carrier concentration can result in a further increase in the diamagnetism of pyrocarbon. Figures 2; references 2: 1 Russian, 1 Western.
[164-1386]

USSR

EFFECT OF THE POLARIZATION OF A VACUUM BY A STRONG MAGNETIC FIELD ON THE CYCLOTRON RADIATION OF A WARM PLASMA

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30 No 2, 1979 pp 137-142 manuscript received 6 Jun 79

PAVLOV, G. G., SHIBANOV, YU. A. and GNEDIN, YU. N., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] The polarization of an electron-positron vacuum by a magnetic field is known to qualitatively alter, under certain conditions, the spectrum, polarization, and angular distribution of cyclotron radiation of a cold plasma. The applicability of this finding to a warm plasma was investigated on deriving formulas for the absorption and refraction coefficients and the polarization of normal waves at $k_{\perp} < T$. It follows from these formulas that, under the same conditions as for a cold plasma, the polarization of the "vacuum" (the virtual production of electron-positron pairs) qualitatively alters the spectrum, polarization, and angular distribution of the cyclotron radiation of a collisionless plasma. These changes should be taken into account in the interpretation of the spectral singularities in the emission of X-ray pulsars that are identified with cyclotron lines. Figures 3; references 7: 4 Russian, 3 Western.
[161-1386]

USSR

UDC 621.378.324

INVESTIGATION OF THE ACTIVE MEDIUM OF A RAPID-FLOW CO₂ LASER WITH SEMI-SELF-MAINTAINED DISCHARGE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1442-1445 manuscript received 9 Oct 78

ARTAMONOVA, A. V., NAUMOV, V. G., SHACHKIN, L. V. and SHASHKOV, V. M.

[Abstract] The active medium excited by a semi-self-maintained combined discharge (through the ionization of the medium in the flow of the CO₂-N₂-He mixture by short electrical pulses) is investigated with the object of substantiating this method for the pumping of rapid-flow gas lasers. The study was performed in a discharge chamber in which the discharge was accomplished in such a manner as to orient the electrical current at right angles to the gas flow. The attendant measurements of the energy balance (maximum energy input, amplification, and heating of the gas as functions of composition of the CO₂-N₂-He mixture show that in lasers of this type, when used on a technological scale, the efficiency of the vibrational excitation of atoms of nitrogen and carbon dioxide reaches ~90% and the specific energy reaches 400-450 J/g. These findings are useful to the development of high-power technological closed-cycle CO₂ lasers. Figures 5; references 7: 6 Russian, 1 Western.

[157-1386]

USSR

UDC 621.378.324

MECHANISM OF DIRECT HEATING OF CO₂-N₂-He LASER MIXTURE IN A SEMI-SELF-MAINTAINED DISCHARGES

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1446-1451 manuscript received 27 Oct 78

KOCHETOV, I. V., NAUMOV, V. G., PEVGOV, V. G. and SHASHKOV, V. M.

[Abstract] The proportion of energy expended on the direct heating of the CO₂-N₂-He mixture under conditions typical of a semi-self-maintained glow discharge was experimentally determined, along with an experimental and theoretical analysis of the possible electron energy loss channels resulting in that direct heating. The experiments were performed in the discharge chamber of a rapid-flow CW CO₂ laser with pumping of the laser mixture by means of a combined discharge. A formula for the proportion of energy spent on direct heating and representing the sum total of energy losses due to elastic collisions and the excitation of rotations and lower vibrational levels of the CO₂ molecules is presented. A new value of the excitation cross section--for excitation due to electron impact--is derived for the 01¹0 level of the CO₂ molecule. Figures 8; references 14: 6 Russian, 8 Western.

[157-1386]

CHAIN MECHANISM OF EXCITATION OF A CW HYDROGEN FLUORIDE LASER WITH A CYLINDRICAL NOZZLE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1476-1483
manuscript received 5 Nov 78

STEPANOV, A. A. and SHCHEGLOV, V. A., Moscow, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The energy potential of supersonic hydrogen fluoride lasers is still far from exhausted and its exploitation hinges on implementing the chain mechanism of excitation, $F + H_2 \rightarrow HF(v) + H$, $-\Delta H_1 = 31.7$ kcal/mole (1) and $H + F_2 \rightarrow HF(v) + F$, $-\Delta H_2 = 97.9$ kcal/mole (2). The chain process (1), (2) is of interest primarily because the chemical energy released in the form of the vibrational energy of the excited HF molecules is greater than in the case of the single-act pumping reaction (1), with "hot" reaction (2) then becoming dominant. If the chain mechanism is to be translated into reality, a laser with cylindrical nozzle will be needed. In this connection, the energy potential and other special features of such a laser are analyzed on the basis of a solution of the Navier-Stokes equations of the chemically reacting mixture (in the boundary layer approximation) with allowance for processes of vibrational and radiational kinetics. It is shown that the selection of the optimal nozzle geometry in chain pumping assures a marked neutralization of the thermal effect and transition to higher static pressures in the cavity region, as well as the attainment of extremely high levels of chemical efficiency, unit laser energy, and laser capacity. Figures 6; references 13: 6 Russian, 7 Western.
[157-1386]

IODINE LASER WITH REUTILIZATION OF RECOVERED MIXTURE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1493-1499
manuscript received 29 Nov 78

CAVRILINA, L. K., KATULIN, V. A., KORZHAVINA, N. N., LEONOV, YU. S., MOROZOV, YU. I., NOSACH, V. YU. and PETROV, A. L., Moscow, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] In high-power iodine lasers operating on large quantities of gas mixture (e.g. $C_3F_7I-SF_6$) the spent gas has to be replaced because the photodissociation of C_3F_7I in the mixture with other products results in the formation of I_2 which is an extremely strong damper of excited iodine atoms. At the same time the amount of the buffer gas SF_6 in the mixture remains unchanged. This raises the problem of eliminating impurities from the spent mixture so as to reuse it. In this connection, two techniques of purifying the spent gas mixture were developed and tested: its separation into discrete components by means of isothermal evaporation, and by means of chromatography (passing the mixture through an adsorbent-containing column). At the present stage, the chromatographic method is more promising: the optimal adsorbent was found to be molecular iodine. In the future the use of the chromatographic method will make it possible to resort to a closed-cycle operation with periodic replacement of the adsorbent, thus making it possible to repeatedly reuse the buffer gas SF_6 , or using a system with multiple initiation of discharge. Figures 3; references 5: 4 Russian, 1 Western.
[157-1386]

SPECTROSCOPIC INVESTIGATION OF THE POWER RESONANCES OF He-Ne/ CH_4 RING LASERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1500-1506 manuscript received 20 Jan 77; after editing 4 Dec 78

BELENOV, E. M., GUBIN, M. A., GUSEV, V. M., NIKITIN, V. V. and NIKOLAYENKO, A. N., Moscow, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The findings of experimental spectroscopic research into the width, amplitude, and frequency peak of the power resonances of He-Ne ring lasers ($\lambda = 3.39 \mu$) with a methane absorption cell in relation to the pressures of the active and passive media and the magnitude and phase of wave coupling due to scattering are presented. The experimental setup consisted

of three parts: an optical part, a system for adjusting the pressures of the active (He-Ne) and passive (CH_4) media, and a radiation recording and automatic frequency control system. The conditions that must be satisfied by the laser's parameters in order to assure stable narrow Lorentz-profile resonances located at the center of the absorption line are specified. The frequency of ring lasers is stabilized and the frequency shifts of power resonances determining the reproducibility of the frequency of the He-Ne/ CH_4 ring laser are investigated. Figures 8; references 8: 7 Russian, 1 Western.
[157-1386]

USSR

UDC 621.378.33

ENERGY CHARACTERISTICS OF THE PHOTOCHEMICAL XeO LASER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1513-1522 manuscript received 31 Jan 79

ZUYEV, V. S., MIKHEYEV, L. D. and POGOREL'SKIY, I. V., Moscow, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The kinetics of physicochemical processes occurring in the active medium of a photochemical XeO laser is investigated, and the applicability of the derived analytic formulas to the description of the output characteristics of that laser is experimentally demonstrated. For the $\text{N}_2\text{O}:\text{Xe}:\text{He}$ mixture having the component ratio 1:75:170 a pulse energy of 2.2 joules was achieved, setting a record for pulsed gas lasers in the visible region. This was accomplished in the presence of a concentration of 3 amagat and at a temperature of 160 K. The specific lasing energy amounted to ~3 joules per liter and the quantum efficiency with respect to absorbed photons was about 10%. It was found that the maximum loss of pumping power is due to the high internal losses in the active medium of the laser and hence increasing the optical homogeneity of the active medium is to be regarded as the principal means of increasing the efficiency of the XeO laser. Figures 5; references 12: 7 Russian, 5 Western.
[157-1386]

XeF LASER EXCITED BY AN ELECTRON BEAM

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY, FIZIKA in Russian No 3 (202), 1979 pp 111-113 manuscript received 6 Feb 78; after revision 30 May 78

BYCHKOV, YU. I., KONOVALOV, I. N. and TARASENKO, V. F., Institute of High-Current Electronics, USSR Academy of Sciences Siberian Department

[Abstract] Lasing in a mixture of Ar-Xe with NF_3 and F_2 using free-bound transitions of the XeF^* molecule with electron beam excitation was obtained in earlier studies. In this paper the authors investigate the energy, time and spectral characteristics of an electron-beam pumped XeF laser on an Ar-Xe mixture with fluorine-carriers NF_3 and SF_6 . The electron beam excitation had an energy level of 300 keV, current density of 75 A/cm^2 and current pulse duration of 50 ns. The electron beam was admitted through a $20 \times 1 \text{ cm}^2$ window sealed with iron foil 25 microns thick into a laser tube 30 centimeters long and 2 centimeters in diameter. A planar aluminum mirror and plane-parallel quartz plate were placed at the ends of the tube forming an optical resonator. Analysis of spectograms of laser emission showed that lasing under all conditions tested takes place in two lines with wavelengths of approximately 351 and 353 nanometers with virtually identical intensity. The use of NF_3 as a fluorine donor yields emission energy 4.5 times greater than SF_6 . Replacement of the quartz plate with dielectrically-coated mirrors led to a decrease in emission energy. At peak emission energy, efficiency in mixtures with NF_3 was about 1 percent, while in mixtures with SF_6 it was about 0.1 percent. Figures 4; references 4: 1 Russian, 3 Western.

[130-8617]

BIMODAL He-Ne LASERS IN AXIAL MAGNETIC FIELD

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 76, No 6, 1979 pp 1950-1959 manuscript received 11 Dec 78

YERMACHENKO, V. M., KONOVALOV, I. P., PETROVSKIY, V. N., PROTSENKO, YE. D., and RURUKIN, A. N., Moscow Engineering Physics Institute

[Abstract] Considering that the axial magnetic field is shown to markedly affect the characteristics of unimodal gas lasers, it was of interest to investigate the effect of that field on the principal characteristics of bimodal gas lasers--critical frequency, range of continuous adjustment of

intermodal distance, region of bimodal emission, and frequency or intermodal beats for different patterns of polarization of the fields of interacting modes. Accordingly, these characteristics were investigated both in experiment and in theory for bimodal He-Ne lasers with orthogonally polarized modes in an axial magnetic field. It was found that the magnetic field consistently increases the critical frequency, i. e. strengthens the coupling between modes. The varying pattern of behavior of the bimodal lasing regime in the magnetic field in the presence of different configurations of phase anisotropy of the cavity resonator is attributable to the differences in the pattern of polarization of the wave modes: identically polarized waves interact with the same σ -component of the Zeeman doublet, while oppositely polarized waves interact with different σ -components. A formula for the frequency of intermodal beats as a function of the frequency difference is derived. Figures 5; references 12: 10 Russian, 2 Western.

[151-1386]

USSR

STOCHASTIC MECHANISM OF EXCITATION OF MOLECULES INTERACTING WITH THEIR OWN RADIATION FIELD

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 76, No 6, 1979 pp 1960-1968 manuscript received 18 Dec 78

BELOBROV, P. I., BERMAN, G. P., ZASLAVSKIY, G. M. and SLIVINSKIY, A. P., Physics Institute imeni L. V. Kirenskiy, Siberian Affiliate of the USSR Academy of Sciences

[Abstract] The possibility of the excitation of a multi-level quantum vibrational system through interaction with the self-consistent radiation field in the presence of a stochastic instability is investigated numerically. The model taken for the investigation was a system of nonlinear quantum oscillators (molecules) interacting with an external coherent field of laser radiation as well as with their own radiation field, considered in the classical unimodal approximation. The conditions for the formation of the stochastic regime of excitation of the higher levels in the system are derived. It is shown that a major readjustment of the distribution function of level populations takes place in the region of stochastic motion. The stimulation of a self-consistent radiation field in the system is accompanied by an increase in the populations of higher levels. The nature of level populations for a system exposed to the action of several external fields in resonance with various nonlinear-oscillator transitions is investigated in the presence of stochastic instability in the system. The investigated effect may be regarded as one of the possible mechanism of the stochastic excitation of polyatomic molecules into the region of

higher levels of the vibrational spectrum. When allowance is made for multimodality of the self-consistent radiation field and the three-dimensionality of real molecules, the critical interaction constant at which a stochastic regime of motion develops in the system can be markedly lowered. Figures 8; references 11: 9 Russian, 2 Western.

[151-1386]

USSR

QUANTUM THEORY OF INDUCED PROCESSES IN THE FREE-ELECTRON LASER

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 76 No 6, 1979 pp 1996-2010 manuscript received 23 Jan 79

McIVER, J. and FEDOROV, M. V., Physics Institute imeni P. N. Lebedev. USSR Academy of Sciences

[Abstract] General quantum-mechanics equations of the electron in a spatially periodic magnetic field as well as in an electromagnetic wave field are derived on the basis of the interpretation of these effects in terms of induced bremsstrahlung and absorption. Analysis of the exact equations is used to derive the limits of applicability of the calculations with respect to the theory of lower-order first-order magnetic field and first-order electromagnetic wave field perturbations. It is shown that, as regards calculations of the amplification factor, these limits are much more rigid than in the general case, which is associated with the marked compensation of higher-order corrections of the amplification factor. The saturation parameter μ is determined and the asymptotic μ -dependence of the amplification factor for $\mu > 1$ is derived. The spectral properties of the amplification factor—width and displacement of the resonance maximum which depend on field intensities, are established. An analytic formula for the (spectrally) maximum amplification factor is derived: this factor is found to decrease with increase in the intensity E_0 of the amplified wave as $E_0^{-3/2}$. Figures 3; references 26: 13 Russian, 13 Western.

[152-1386]

EXCITATION OF SOLUTIONS AND MIXTURES OF DYES BY MEANS OF COPPER-VAPOR LASER RADIATION

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1536-1539 manuscript received 15 Oct 78

MASARNOVSKIY, L. V., SOLDATOV, A. N. and SUKHANOV, V. B., Tomsk, Special Design Bureau of Scientific Instrumentmaking "Optika," Siberian Affiliate of the USSR Academy of Sciences

[Abstract] The range of applications of metal-vapor lasers can be broadened if the discrete series of wavelengths they generate is converted to frequency-adjusted coherent radiation. This problem can be solved by using metal-vapor lasers as pumping sources for lasers based on organic dyes. In this connection, findings are presented on the use of a ≤ 4 watt Cu laser to excite several dyes and their mixtures lasing in the green-red region of the visible portion of the spectrum, namely, ethanol solutions of uranine, rhodamine R6Zh, rhodamine V, and cresyl violet, as well as their mixtures. Of the substances investigated, the most marked positive effect was produced by the two-frequency excitation of the mixture of rhodamine R6Zh with cresyl violet, which more than doubled the efficiency associated with the transfer of excitation energy owing to the fact that the pumping lines 510.6 and 578.2 nm lie within the absorption bands of the donor and the acceptor, respectively, along with a favorable ratio between quantum yields and a satisfactory overlap of the profiles of luminescence (R6Zh) and absorption (cresyl violet). It should also be noted that the use of a dispersion-type cavity resonator in the liquid laser will make it possible to completely cover the 520-670 nm spectral range by means of the dyes tested, thus markedly broadening the potential of copper-vapor lasers. Figures 3; references 9: 6 Russian, 3 Western.

[157-1386]

USSR

UDC 621.378.33

POWER OUTPUT STABILITY OF A CW CO LASER EMITTING THE FUNDAMENTAL SPATIAL MODE

Moscow KVANTOVAYA ELEKTRONIKA Vol 6 No 7, 1979 pp 1556-1559 manuscript received 14 Dec 78

ALEYNIKOV, V. S. and MASYCHEV, V. I.

[Abstract] The amplitude stability of the power output of CO and CO₂ lasers emitting the fundamental spatial mode but lacking stabilization with respect to frequency was investigated. Lasers of this kind are useful for many technological purposes involving the need for high power densities at the target. It is established that for those technological applications which require a single spatial mode and in which the spectral composition of the radiation is not an important factor, the use of CO lasers serves in principle to attain a higher power output stability than does the use of CO₂ lasers. Moreover, owing to their shorter radiation wavelength, sealed CO lasers displaying energy parameters comparable to those of CO₂ lasers assure a higher power density at the focus on a target. The use of a CW CO laser emitting simultaneously at a large number of cascade-coupled vibrational-rotational transitions makes it possible to achieve a relatively high power output stability on the basis of a single spatial mode without using frequency-control devices. Figures 3; references 1 (Russian).
[157-1386]

USSR

UDC 621.373.826.038.825.3

A MATHEMATICAL MODEL OF REPETITIVELY Q-SWITCHED NEODYMIUM-GLASS LASERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1578-1580 manuscript received 28 Jun 78

BYKOVSKIY, N. YE., DOROFYEV, V. I., and SENATSKIY, YU. V., Moscow, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Repetitively Q-switched neodymium-glass lasers (RQNL) with their extremely short (about 0.5 nanosecond) pulses represent a promising source of short pulses for applied research. But since their mechanism of action is different, its theoretical description does not reduce to known models. In this connection, a mathematical model of RQNL is constructed, with the calculations being based on the successive solution of the problem of the

passage of a radiation pulse through the active medium and the shutter, which is considered as coinciding with one of the mirrors. The theoretical findings are found to be in agreement with experiment. It is shown that, given a specific pattern of Q-switching in lasers with a nonlinear absorber the pulse duration can be shortened to as little as 0.01-0.1 nanosecond. Figures 4; references 4 (Russian).
[157-1386]

USSR

UDC 621.373.8.038.825.3

RADIATIONLESS TRANSFER OF ENERGY FROM Cr^{3+} IONS TO Nd^{3+} IONS IN HIGH-CONCENTRATION NEODYMIUM-DOPED GLASS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1583-1585 manuscript received 26 Jan 79

AVANESOV, A. G., VORON'KOV, YU. K., DENKER, B. I., MAKSIMOVA, G. V., OSIKO, V. V., PROKHOROV, A. M. and SHCHERBAKOV, I. A., Moscow, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] One way of enhancing the pumping efficiency of solid neodymium lasers is to dope the laser matrix with ions such as Cr^{3+} , which can absorb energy and then transmit it to neodymium ions, thus sensitizing the luminescence of the latter. This possibility is now investigated on using special Li-La phosphate glass containing high concentrations of neodymium ions ($>10^{21} \text{ cm}^{-3}$), specially developed at the Lebedev Institute of Physics. The absorption and luminescence spectra as well as the luminescence damping kinetics of Cr^{3+} and Nd^{3+} were investigated. It was established that the time of energy transfer from Cr^{3+} to Nd^{3+} was $\leq 10 \text{ } \mu\text{sec}$, and that the band intensity ratio of Cr^{3+} to Nd^{3+} remained virtually unchanged in the luminescence absorption and excitation spectra of Nd^{3+} specimens with the concentration $\text{Nd}^{3+} > 8 \cdot 10^{20} \text{ cm}^{-3}$, which points to a radiationless transfer of energy from Cr^{3+} to Nd^{3+} at both $T = 77 \text{ K}$ and $T = 300 \text{ K}$. Such high rates of the transfer of excitation from Cr^{3+} to Nd^{3+} are associated with the mutual closeness of the interacting ions and the satisfactory overlap of the optical spectra of the donors and the acceptors. Figures 2; references 10: 6 Russian, 4 Western.
[157-1386]

USSR

UDC 621.373.826.038.825.3

INVESTIGATION OF THE LASING CHARACTERISTICS OF ACTIVE ELEMENTS MADE OF Li-Nd-La PHOSPHATE GLASS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1586-1588
manuscript received 31 Jan 79

AVANESOV, A. G., VASIL'YEV, I. V., VORON'KO, YU. K., DENKER, B. I., ZINOV'YEV, S. V., KUZNETSOV, A. S., OSIKO, V. V., PASHININ, P. P., PROKHOROV, A. M. and SEMENOV, A. A., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] This is a comparison study of the lasing characteristics of active elements made of Li-Nd-La phosphate glass (Nd^{3+} ion concentration $8 \cdot 10^{20} \text{ cm}^{-3}$) and neodymium-doped yttrium-aluminum garnet (YAG, or $\text{Y}_3\text{Al}_5\text{O}_{12}-\text{Nd}^{3+}$, with Nd^{3+} ion concentration $1.3 \cdot 10^{20} \text{ cm}^{-3}$), both having the same dimensions (5x30 mm). For the active elements of Li-Nd-La phosphate glass the threshold pumping energy was 1 joule and the dynamic efficiency was 1.5 times as high as the maximum for YAG. This makes it possible to achieve a total laser efficiency of ~0.5% for 2-joule pumping and of more than 1% for 4-joule pumping. Thus the use of Li-Nd-La phosphate glass as an active medium for repetitively pulsed lasers is promising, as in a number of cases it serves to achieve improved lasing characteristics of active elements compared with the use of YAG:Nd crystals. Figures 3; references 5 (Russian).
[157-1386]

USSR

UDC 621.378.325

SEALED COPPER-VAPOR LASER OPERATING AT ATMOSPHERIC PRESSURE OF BUFFER GAS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1589-1590 manuscript received 4 Dec 78

The late BURMAKIN, V. A., YEVTYUNIN, A. N. and LESNOY, M. A.

[Abstract] Buffer-gas pressure in a pulsed laser is extremely important at certain transitions of the Cu atom, since it influences output power and the flow rate of the medium. In this connection, the possibility of increasing buffer-gas pressure to atmospheric pressure in a sealed copper-vapor laser with a discharge tube of 2 cm diameter and 86 cm length was investigated on measuring service life as a function of buffer gas pressure (from 20 to 750 mm Hg). It was found that when buffer-gas (neon) pressure is increased to 1 atm, the laser output power is reduced to half (from 18 to 8 watt) but, on

the other hand, the service life of the laser is then prolonged to about 8,000 hr, compared with 200 hr at buffer gas pressure of 20 mm Hg. It can thus be expected that use of high buffer gas pressures will make it possible to develop copper-vapor lasers operating at pulse frequencies exceeding 100 kHz, since then the required rate of collision relaxation of the lower metastable level should be assured. Figures 1; references 2 (Russian). [157-1386]

USSR

LASING IN THE 3.3-3.6 μ m REGION IN COOLED NITROGEN

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 29 No 11, 5 Jun 79 pp 688-692 manuscript received 7 Apr 79

ZAROSLOV, D. YU., KARLOV, N. V., KASLIN, V. M., KOVALEV, I. O., KUZ'MIN, G. P. and PROKHOROV, A. M., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] A liquid-nitrogen cooled chamber was used to achieve simultaneous laser pulsing on electron transitions $\omega \rightarrow \alpha$ and $\alpha \rightarrow \alpha'$ of the N_2 molecule, emitting in the 3.6 and 3.3 μ m regions, respectively. The pulse energy was 0.5 μ sec long and reached 0.5 mJ. Intense lasing was observed on five lines belonging in the 2-1 band of the system $\alpha^2\Pi_g \rightarrow \alpha'^2\Sigma_u^-$ and the 0-0 band of the system $\omega^1\Delta_u \rightarrow \alpha^2\Pi_g$. The total power output for all five lines reached 1 kW. These findings demonstrate that lasing on these bands of the N_2 molecule can result in sufficiently strong radiation in the practically important 3.3 and 3.6 μ m regions, under condition of deep cooling and large-volume transverse discharge. It is assumed that for the systems specified the nitrogen molecule implements a new cascade mechanism for inducing inversion, consisting in the excitation of the upper laser levels by direct electron shock in accordance with the Franck-Condon principle. Figures 2; references 6: 2 Russian, 4 Western. [163-1386]

USSR

OBSERVATION OF A GAP IN THE SPECTRUM OF SPONTANEOUS RADIATION AND LASING
SATURATION IN SINGLE-MODE SEMICONDUCTOR LASERS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 29 No 11, 5 Jun 79 pp 709-713 manuscript received 18 Apr 79

YELESIN, V. F., YERKO, A. I. and LARKIN, A. I., Moscow Engineering Physics
Institute

[Abstract] In the electron spectrum of a semiconductor in a strong electromagnetic field with a quantum energy exceeding the width of the forbidden band, a gap is known to appear due to the strong electron-photon interaction which eliminates degeneracy in the electron-photon system. Extension of this theory to the spectrum of spontaneous radiation implies that a gap should form in the neighborhood of the oscillation frequency. This assumption was investigated with the aid of an injection-type semiconductor laser with a radiation intensity of $\sim 10^6$ W/cm², incorporating a holographic selector. The existence of the gap in the spectrum of spontaneous radiation was discovered. The power output associated with the formation of the gap as well as the width of the gap and its dependence on intensity warrant interpreting this effect as the formation of a gap in the energy spectrum of electrons. Saturation of single-mode lasing was observed up to the threshold of formation of the second mode. The maximum power output and its square-law dependence on photon lifetime in the laser cavity are in agreement with the kinetic theory of lasers. Figures 2; references 9: 7 Russian, 2 Western.
[163-1386]

USSR

INDUCED COMPTON SCATTERING ON A RELATIVISTIC ELECTRON BEAM

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 76
No 6, 1979 pp 2065-2073 manuscript received 6 Dec 78

ZHUKOV, P. G., IVANOV, V. S., RABINOVICH, M. S., RAYZER, M. D. and RUKHADZE, A. A., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The induced Compton scattering effect predicted by Dirac and Kapitza has now been experimentally observed. This effect should make it possible to convert longwave electromagnetic radiation to its shortwave counterpart and hence is a major interest. In this connection, the induced Compton scattering of centimeter-range electromagnetic waves on a relativistic electron beam in a circular metal waveguide is investigated in experiment and in theory. In particular, the dependence of the frequencies of scattered radiation on system parameters and on the frequency of incident radiation is analyzed and the conditions for disregarding the thermal scatter of the electron beam are indicated. Comparison of the findings of theory with those of experiment as regards the relationship between the power of the radiation scattered at various frequencies and the power of the incident wave leads to the conclusion that the observed scattering is of an induced nature. The experimental conditions in which the partial reflection of scattered radiation from the ends of the system becomes substantial and the process of induced scattering is transformed to stimulated emission are formulated. Figures 3; references 11: 9 Russian, 2 Western.

[151-1386]

USSR

GENERATION OF THE $2\omega_0$ HARMONIC IN LASER PLASMA

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 76
No 6, 1979 pp 2094-2109 manuscript received 25 Jan 79

BASOV, N. G., BYCHENKOV, V. YU., KROKHIN, O. N., OSIPOV, M. V., RUPASOV, A. A., SILIN, V. P., SKLIZKOV, G. V., STARODUB, A. N., TIKHNOCHUK, V. T. and SHIKANOV, A. S., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[abstract] The discovery in the early 1970s of the second harmonic was one of the first proofs of the manifestation of nonlinear effects during the interaction between laser radiation and the plasma it creates. In

particular, the existence of this harmonic is of major interest in connection with the attempts to utilize the optical emission of a laser plasma to obtain information on the nonlinear processes occurring in its "corona." An adequate description of the physical processes occurring in that corona requires constructing a theoretical model of lasing on the $2\omega_0$ harmonic. Such a model is constructed in this paper: formulas for the intensity, spectrum, and angular and polarization characteristics of that harmonic in the presence of moderate fluxes of laser radiation are presented, and are found to be in agreement with experimental studies of that model in the Kal'mar multi-channel laser facility in experiments with spherically symmetric irradiation of shell targets, as well as with hydrodynamic calculations. Further, all the currently known experimental data on stimulation of the second harmonic are analyzed and found to be adequately accounted for by the new model. This demonstrates the validity of the new techniques for rapid assessment of the parameters of plasma and plasma turbulence according to the characteristics of its radiation at the frequency of the second harmonic. In particular, that harmonic can be utilized to determine such parameters of the corona as the density inhomogeneity and the rate of motion of the critical surface. The presented method can be used not only in research into laser-heated plasmas but also in research into other plasmas, e. g. plasmas heated by electron and ion beams, with the object of determining plasma parameters and the region of near-critical density with respect to the radiation applied. Figures 7; references 44: 32 Russian, 17 Western.

[152-1386]

USSR

DOUBLE CHARGE EXCHANGE OF π -MESONS ON STRANGENESS-CHANGING NUCLEI

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 30 No 2, 1979 pp 142-145 manuscript received 8 Jun 79

BIRYUKOV, YU. A., GORNOV, M. G., LAPUSHKIN, S. V., PICHUGIN, A. P., PONGOSOV, A. K. and SERGEYEV, F. M., Moscow Engineering Physics Institute

[Abstract] The double charge-exchange reaction of pions on nuclei is a many-nucleon hadron-nuclear interaction of increasing interest. The authors were the first to observe double charge-exchange reactions of π^- -mesons on strangeness-changing nuclei ($\pi^- \rightarrow K$) as well as the transitions $\pi^- \rightarrow \pi^+ K^0$, in a 105-cm freon bubble chamber. In this connection, a method for measuring reaction cross sections without identifying the K^+ -meson, on the basis of strangeness conservation in nuclear interactions, is proposed. The experimental findings indicate that the mechanism of reactions of the double charge-exchange type is of a two-stage nature, with formation of an additional soft π^- -meson in the elementary process during the first stage, and absorption of that meson during the second. Several nucleons of the nucleus ($n > 2$) can simultaneously take part in the reaction. Figures 1; references 7: 6 Russian, 1 Western.

[161-1386]

USSR

COHERENT HADRONIC RADIATION AT SUPERHIGH ENERGIES

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 30 No 2, 1979 pp 152-156 manuscript received 8 Jun 79

DREMIN, I. M., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] It is shown that high-energy hadrons ($E_{lab} \gtrsim 10$ TeV) moving in a nuclear-active medium (nucleus or nucleon) can produce coherent radiation analogous to the Vavilov-Cherenkov radiation in the case of electromagnetic fields. The process is of a threshold nature with respect to energy: it can take place when the energy of the primary hadron markedly exceeds 1 TeV and the energies of the emitted pions exceed 100 GeV. If the energy of the emitted pion is ~ 1 TeV the transverse momentum $\gtrsim 2$ GeV/c. Thus coherent hadronic radiation takes place with considerable transverse momenta. This concerns the possibility of the appearance of a new hadronic interaction effect in the presence of superhigh energies—an effect which results in an increase in the

proportion of particles with large transverse momenta, aside and apart from the basic mechanism of generation of particles with small transverse momenta. Figures 1; references 8: 7 Russian, 1 Western. [161-1386]

USSR

A NEW INTERPRETATION OF CERTAIN ANOMALOUS EVENTS IN COSMIC RAYS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 30 No 2, 1979 pp 157-161 manuscript received 15 Jun 79

APANASENKO, A. V., DOBROTIN, N. A., DREMIN, I. M. and KOTEL'NIKOV, K. A.

[Abstract] The experimental findings on hadronic interactions in cosmic rays at energies exceeding 100 TeV point to a possible variation in the multiple production mechanism at superhigh energies. Thus there exist indications of a marked increase in the mean transverse momentum and the appearance of events entailing the production of a large number of particles within a short range of velocities. These two facts are now interpreted as reflecting the possible manifestation of a new effect in hadron physics--coherent hadronic radiation, analogous to the Vavilov-Cherenkov radiation in electromagnetic fields. In this connection, the importance of the analysis of the pseudovelocity distribution of secondary particles in events with energies of 100 TeV and higher deserves emphasis, since the detection of peaks in such distributions may corroborate this interpretation. Figures 4; references 9: 5 Russian, 4 Western. [161-1386]

USSR

RECONSTRUCTION OF THE ENERGY SPECTRA OF THE NEUTRINO BEAM AT THE INSTITUTE OF HIGH-ENERGY PHYSICS

Moscow YADERNAYA FIZIKA in Russian Vol 29 No 6, 1979 pp 1506-1512 manuscript received 31 Jul 78

BIGORSKIY, A. P., VOVENKO, A. S., VOLKOV, A. A., KARTASHEVA, V. G., KOCHETKOV, V. I., LAPIN, V. V., MUKHIN, A. I., SVIRIDOV, YU. M. and FAKHRUTDINOV, R. M., Institute of High-Energy Physics, Serpukhov

[Abstract] Good knowledge of the energy distribution of neutrino (or anti-neutrino) flux passing through detectors is essential for a successful study of the quantitative characteristics of neutrino interaction in experiments with accelerators. A description is given of the method of determining this flux used in neutrino experiments at the USSR Institute of High-Energy Physics. This method consists in direct calculation from the known yield of π - and K-mesons from a real target, for the reconstruction of neutrino spectra, whereby an analysis of measured muon flux provides information for making necessary corrections. The main sources of neutrinos are the lepton decay of π - and K-mesons formed when protons interact with the target. A focusing system consisting of four parabolic lenses is employed to increase the intensity of the neutrino flux passing through detectors. It is possible to switch from a neutrino beam to an antineutrino beam by changing the direction of the magnetic field of the focusing system. The focusing system both focuses mesons of a specific sign and defocuses those of the opposite sign. Beyond the π - and K-meson lepton channel, the system includes a muon filter containing ionization chambers and scintillation counters, followed by a spark detector. The geometry of the system for forming the neutrino beam determines the calculation procedure described. The procedure for calculating neutrino energy spectra and muon flux consisted of computations performed by a Monte Carlo method by using a specially written program. When charged particles passed through the focusing system their paths of travel in the magnetic fields of the lenses were computed. Each event was assigned a weight proportional to the probability of arrival at the detector, the probability of arrival at the detector, the probability of decay at a given length and the number of nascent mesons within a fixed angle and pulse range. The muon flux in the shield was measured by means of a system of ionization chambers. The first 12 sections of the muon filter contained a unit containing three detectors with different measurement ranges for the density of the muon flux, positioned behind one another in the direction of the beam. These units could be remotely set into any of 225 positions vertically and horizontally in the plane of the shield's cross section. The distribution of the muon flux was measured simultaneously in all sections. Computed values of muon flux agreed with the experimental within an error range of seven percent, proving the high reliability of the method employed. A graphic comparison is shown of the experimental distribution of neutrino interaction over the radius of the neutrino spark detector and of the computed radial

distribution of neutrino interaction. Good agreement is evidenced. Experimental errors in determination of the neutrino spectra equal eight percent for π -meson decay and 11 percent for K-meson decay. Figures 7; references 12: 8 Russian, 4 Western.
[144-8831]

USSR

DETECTION OF $\omega \rightarrow \pi^0 \mu^+ \mu^-$ DECAY

Moscow YADERNAYA FIZIKA in Russian Vol 29 No 6, 1979 pp 1513-1515 manuscript received 12 Feb 79

VIKTOROV, V. A., GOLOVKIN, S. V., GRITSUK, M. V., DZHELYADIN, R. I., ZAYTSEV, A. M., KAKAURIDZE, D. B., KACHANOV, V. A., KONOPLYANNIKOV, A. K., KONSTANTINOV, A. S., KONSTANTINOV, V. S., KUBAROVSKIY, V. B., KULIK, A. V., LANDSBERG, L. G., LEONT'YEV, V. M., MUKHIN, V. A., OBRAZTSOV, V. S., PETRUNINA, T. I., POKROVSKIY, N. S. and PROKOSHKIN, YU. D., Institute of High-Energy Physics, Serpukhov

[Abstract] In a study of mass spectra of $\mu^+ \mu^- \gamma \gamma$ systems formed in $\pi^- p$ collisions with momenta of 25 and 33 GeV/c, a distinct peak was isolated, corresponding to a previously unobserved $\omega \rightarrow \pi^0 \mu^+ \mu^-$ decay. The study was performed with the 70 GeV accelerator at the Institute of High-Energy Physics. Chosen as the source of ω -mesons was the binary reaction $\pi^- p \rightarrow \omega n$, which guaranteed favorable background conditions for experimentation. The effective recording of processes including the formation of muon pairs and particles decaying into gamma quanta was made possible by making measurements with the "Lepton-G" unit, which included primary beam detectors, a target with guard counters, and wire-type proportional and drift chambers for measuring the coordinates of charged particles directly behind the target. A hodoscopic spectrometer with 64 lead glass counters was used to measure the coordinates and energy of gamma quanta and a wide-aperture magnetic spectrometer isolated processes including the emission of muon pairs. Events including the formation in the target of two penetrating particles were isolated by triggering the unit with a system of scintillation counters and hodoscopes. Experiments were conducted with a π^- -meson beam with an intensity of $3 \cdot 10^6$ particles per cycle. At the first stage of processing the experimental data, events were isolated with two energetic muons emitted from the target. Then events were isolated in which muon pairs were accompanied by two gamma quanta. In the distribution by mass of $\pi^0 \mu^+ \mu^-$ systems for events with effective masses of $M_{\gamma\gamma} \approx M_{\pi^0}$, a distinct peak was observed, corresponding to an ω -meson. Thus an experimental

determination was made of the existence of the decay of an ω -meson into a π^0 -meson and muon pair. A determination was made of the relative probability of this decay, and it was found to equal $9 \cdot 10^{-5}$ with a systematic error of 50 percent. Figures 2; references 4: 1 Russian, 3 Western. [144-8831]

USSR

INVESTIGATION OF THE VECTOR FORM FACTOR IN K_{e3}^0 DECAY

Moscow YADERNAYA FIZIKA in Russian Vol 29 No 6, 1979 pp 1516-1518 manuscript received 11 Dec 78

BIRULEV, V. K., VESTERGOMBI, G., GVAKHARIYA, T. V., GENCHEV, V. I., GRIGALASHVILI, T. S., GUS'KOV, B. N., DZHORDZHADZE, V. P., IVANCHENKO, I. M., KARPENKO, N. N., KEKELIDADZE, V. D., KRIVOKHIZHIN, V. G., KUKHTIN, V. V., LIKHACHEV, M. S., MANNO, I., NIKOBADZE, G. I., POZE, A. V., SAVIN, I. A., SENNER, A. YE., SIL'VZSTROV, L. V., SIMONOV, V. YE., TAKHTAMYSHEV, G. G. and TODOROV, P. T., Joint Institute of Nuclear Research

[Abstract] K_{e3}^0 decay was recorded by a filmless spark spectrometer together with other decay modes of neutral kaons in an experiment on the regeneration of neutral kaons in deuterium in the Serpukhov accelerator. About 26,000 K_{e3}^0 decay events were analyzed, in order to study the dependence of the vector form factor, f_+ , included in the matrix element $K_L^0 \rightarrow \pi^+ + e^- + \bar{\nu}_e$ (K_{e3}^0) decay, on the square of the 4-momentum, t imparted to a lepton pair, within the range of zero to 0.1 (GeV/c)^2 . In order to identify K_{e3}^0 decay from secondary electrons, the spectrometer included a sandwich type shower electron detector consisting of alternating layers of a scintillator and lead. Data on the form factor were found by varying the distribution density of experimental events on a Dalitz graph with the theoretically expected distribution obtained in modeling events by a Monte Carlo method. Twenty-six thousand experimental and 60,000 modeled events were subjected to final processing, whereby data were analyzed by two methods. In the model-independent method, the values of the form factor $f_+(t)$ were found for 10 ranges of the square of the 4-momentum, t , in its range of variation from zero to 0.10 (GeV/c)^2 . The value of t is expressed in units of the square of the mass of a pion. It is found that the dependence of f_+ on t can be described well by a linear function. Approximation of the values obtained for $f_+(t)$ with a straight line results in a value of the slope parameter of $\lambda_+ = 0.029 \pm 0.008$. In the second method, the dependence of the vector form factor, f_+ , on t was expressed in the form of a linear expansion, $f_+(t) = f_+(0)(1 + \lambda_+ t/m_\pi^2)$, where m_π is the mass of a pion. The distribution of experimental events on the

Dalitz graph was compared with the distribution of modeled events weighted according to the latter equation. A value was obtained for λ_+ of 0.0286 ± 0.0049 . Taking errors into account, the results of both methods of analysis are found to agree well with one another and with the results of a previous experiment. The average value of parameter λ_+ for two independent experiments on studying K_e^0 decay with a filmless spark spectrometer is $\lambda_+ = 0.0306 \pm 0.0034$. This value is also in good agreement with the value averaged for all known results, i.e., $\lambda_+ = 0.0300 \pm 0.0018$. Figures 1; references 10: 7 Russian, 3 Western.
[144-8831]

USSR

THE $\pi^-p \rightarrow \eta n$ REACTION IN THE 15 to 40 GeV/C MOMENTUM REGION

Moscow YADERNAYA FIZIKA in Russian Vol 29 No 6, 1979 pp 1519-1537 manuscript received 26 Jan 79

APEL, V. D., AUGENSTEIN, K. H., BERTOLUCCI, E., BUSHNIN, YU. B., VINCELLI, M. L., GRACHEV, M. I., DONSKOV, S. V., DZIVOLETTI, M., JOHNSON, R., INYAKIN, A. V., KACHANOV, V. A., KVALIA, M., KITTENBERGER, V., KRASNOKUTSKIY, R. N., KRUGER, M., LEDER, G., LEDNEV, A. A., MANELLI, I., MIKHAYLOV, YU. V., MULLER, H., OBERPARLEITER, R., PERNIKA, M., PROKOSHIN, YU. D., PIERACCINI, G. M., SERGIAMPIETRI, F., SIGURDSSON, G., SKRIBANO, A., TEIS, A., TOROPIN, A. N., FRANCESKINI, R., SCHINZEL, D., SCHNEIDER, H., STAUDENMEIER, H. M., STOYER, M. and SHUVALOV, R. S., United Experiment of the Institute of High-Energy Physics (Serpuukhov, USSR) and the European Nuclear Research Organization [CERN] (Geneva, Switzerland)

[Abstract] The results are given of measurements of the cross sections of the reaction for the formation of η -mesons in π^-p collisions, i.e., in $\pi^-p \rightarrow \eta n$, $\eta \rightarrow 2\gamma$ reactions, with five values of the momentum of the bombarding pion in the range from 15 to 40 GeV/C. This reaction comes under the heading of the simplest charge exchange processes, and at high energies its amplitude is determined by the dominant contribution in the t -channel of just one feature with quantum numbers of the A_2 -meson. More than 300,000 η -mesons were registered in the experiment described, making it possible to extend the range of research on this reaction to $|t| \lesssim 5$ (GeV/c)², whereas this was not possible in previous studies, in which cross sections of this reaction were measured in the region of squares of imparted 4-momenta of $|t| \lesssim 1$ (GeV/c)². Experiments were conducted with a beam of negative particles extracted at a zero angle from the internal target of the 70 GeV accelerator at IFVE [Institute of High-Energy Physics]. Employed in these experiments was the 648-channel NICE hodoscopic spectrometer, by means of which

investigations were made of processes of π^-p scattering with neutral end states. The particle beam was focused on a liquid hydrogen target by a quadrupole lens doublet, onto a spot 1 cm in diameter and was registered with a telescope from scintillation counters. Gas threshold Cherenkov counters isolated π^- -mesons, K^- -mesons and antiprotons and electrons in the beam. The transverse coordinates of beam particles were measured with two groups of proportional chambers, each containing three planes rotated 45° , and by precision hodoscopes. The liquid hydrogen target was in the shape of a cylinder 2.5 cm in diameter and 40 cm long with sidewalls of plastic 2 mm thick. The cylinder's ends were closed with transparent mylar windows with a total thickness of not more than 0.1 mm. The Cherenkov radiation emitted by the particles in the liquid hydrogen passed through the outlet window of the target and was recorded with a photomultiplier tube. The longitudinal coordinate of the point of interaction in the target was reconstructed with reference to the magnitude of the photomultiplier tube's pulse. The target was surrounded with a guard system of counters which were used to isolate events with neutral end states. A hodoscopic scintillation spectrometer was used to register pairs of gamma quanta from the decay of η -mesons in the reaction. A measurement was made simultaneously of the energy of each gamma quantum. The construction of the hodoscopic spectrometer is discussed in detail. Pulses from each of the spectrometer's 648 FEU-87 photomultiplier tubes entered amplitude-to-code converters and the digital information issued from these converters was processed with a TR-86 or IBM-1800 computer. A sketch is given of the display screen image of an event in the reaction. The experiments were conducted in 1974-1975 and measurements were made with five values of π^- -meson momentum. A total of $3 \cdot 10^{11}$ π^- -mesons were passed through the target during the time of the experiment. The data recorded and computer processed occupied 2500 magnetic tapes. The computer data processing program included the recognition and reconstruction of showers from gamma quanta in the spectrometer and a kinematic analysis of events. Peaks were sought in the distribution of signal amplitudes. A kinematic analysis was made of events by utilizing the results of reconstructing the coordinates and energy of gamma quanta. The cross sections arrived at for the reaction are shown. Also given are values of the differential cross sections of the reaction measured with five values of the momentum. Discussed in detail are the region of low $|t|$, the region of high $|t|$ and the effective A_2 trajectory. An amplitude analysis of the reaction with low $|t|$ demonstrated that the amplitudes of scattering with spin flip and without spin flip are parametrized by exponential functions whose exponents are shown to be identical within the range of a few percent. A break is observed in the cross section with $|t| \approx 1 \text{ (GeV/s)}^2$, and the A_2 trajectory in the region of $|t| > 1 \text{ (GeV/s)}^2$ deviates drastically from the linear relationship typical of low $|t|$. Figures 14; references 24: 12 Russian, 12 Western.

[144-8831]

USSR

SOME ASPECTS OF INELASTIC SCATTERING OF π^- MESONS IN PROTONS IN THE MOMENTUM RANGE OF 30 TO 60 GeV/C

Moscow YADERNAYA FIZIKA in Russian Vol 29 No 6, 1979 pp 1538-1544 manuscript received 3 Jan 79

APOKIN, V. D., VASIL'YEV, A. N., DEREVSHCHIKOV, A. A., MATULENKO, YU. A., MESHCHANIN, A. P., MYSNIK, A. I., NURUSHEV, S. B., SARAYKIN, A. I., SIKSIN, V. V., SMIRNOV, YE. V., SOLOV'YEV, L. F., SOLOV'YANOV, V. L. and CHUYKO, B. V., Institute of High-Energy Physics, Serpukhov

[Abstract] An analysis is made of experimental data relating to the reaction $\pi^- + p \rightarrow \pi^- + X$ in the region of small squares of the imparted 4-momentum, t , representative of inelastic reactions in the region of beam particle or target fragmentation included among inclusive processes. Reactions of this sort have properties inherent to diffraction processes. Unlike other single-particle inclusive reactions, the differential cross sections for reactions of this sort depend but slightly on the energy of colliding particles. The reaction was studied with six values of the initial momentum, p_0 : 33.5, 39.5, 45.5, 50.5, 56.7 and 59.4 GeV/C. Invariant differential cross sections, $Ed^3\sigma/dp^3 = \rho$, were obtained with values of $p^2T = 0.004$ to 0.005 (GeV/C) 2 and $x = p/p_0 > 0.91$, where p^2T is the square of the imparted momentum and p is the momentum of the scattered particle. The value of x determined in this manner is linearly dependent on the square of the mass defect, M_X^2 , i.e., $x = 1 - (M_X^2 - M_p^2)/s$, where M_p is the mass of the proton and s is the square of the total energy in the center-of-mass system. The differential cross sections, ρ , were represented in terms of x with a spacing of 0.002, and were united into ranges in terms of p^2T . The values of cross sections for the reaction in mbarn/GeV 2 as a function of x with two values of the initial momentum of 33.5 and 59.4 GeV/C, are given, together with the elastic peak, and also as a function of M_X^2 with six values of p_0 . The behavior of cross sections is different in the region of $M_X^2 < 4$ and $M_X^2 > 4$ GeV 2 . These two cases are discussed individually. With values of $M_X^2 < 2$ GeV, a critical dependence of differential cross sections on M_X^2 is observed. The peak observed in differential cross sections for the reaction in the region of $M_X^2 < 2$ GeV is explained chiefly by the contribution of nucleon resonances into which a proton of the target dissociates. In this region of M_X^2 is also observed a critical dependence of differential cross sections on t . A dependence on the mass defect is observed in cross sections, of the slope parameter for t , of 18 and 8 (GeV/C) $^{-2}$ in the region of $M_X^2 < 4$ and $4 < M_X^2 < 10$ GeV 2 , respectively. No dependence of differential cross sections on s is observed in the range of $M_X^2 = 4$ to 10 GeV 2 . Factorization in the reaction is performed with an accuracy of ± 15 percent for protons and π and K mesons in the region of $|t| \simeq 0.01$ (GeV/C) 2 over a wide range of x . Figures 4; references 22: 7 Russian, 13 Western.

[144-8831]

USSR

FORMATION OF VECTOR MESONS IN HADRON - NUCLEON COLLISIONS, AND TRANSVERSE MOTION OF PARTONS

Moscow YADERNAYA FIZIKA in Russian Vol 29 No 6, 1979 pp 1629-1638 manuscript received 19 Jun 78, after correction 3 Nov 78

GOLUBKOV, YU. A., KONOPLICH, R. V. and NIKITIN, YU. P., Moscow Engineering Physics Institute

[Abstract] Quark parton models have been used extensively in recent years to describe processes of hadron - nucleon collisions, whereby it is ordinarily assumed that the distribution of partons in terms of transverse momentum does not depend on the longitudinal momentum, and that the mean value of a parton's transverse momentum is fixed and low. Contradictory data have indicated that the transverse momentum of partons is not low and can reach a value of approximately 1 GeV/c. In this study the transverse momentum of partons is taken into account, and based on the quark parton "fusion" mechanism, a distinct analytical expression is obtained for the inclusive cross section of the formation of vector mesons, taking into account the transverse motion of quarks, making it possible to make a direct study of the influence of the transverse motion of partons on the inclusive spectra of secondary hadrons. The quark parton model for the fusion of a quark and antiquark into a meson represents a model making it possible to describe the inclusive spectra of mesons formed in NN collisions within certain ranges of kinematic variables. The model for the "fusion" of quarks is interesting in that it has been used successfully to describe the behavior of inclusive distributions in terms of speed in processes for the formation of vector mesons. It is assumed that partons have a Gaussian distribution in terms of transverse momentum. Equations are derived for the inclusive cross section, by means of which a qualitative and quantitative description is given of the spectra of ρ^0 and J/ψ mesons in terms of speed and transverse momentum. A determination is made of the constants for the "fusion" of quarks with the necessary quantum numbers into ρ^0 and ψ mesons, as well as of the "fusion" constant for ordinary quarks into a J/ψ meson. The results obtained together with the successful quantitative and qualitative description of the spectra of vector mesons formed, in terms of all kinematic variables prove the importance of the role of the "fusion" mechanism for quarks in processes of the formation of vector particles, especially at the center of the speed spectrum. It is demonstrated that quark parton models successfully describe experimental data on the distribution of vector mesons in terms of transverse momentum. Figures 7; references 16: 4 Russian, 12 Western.

[144-8831]

USSR

UDC: 538.4

ON THE POSSIBILITY OF OBSERVING NEW MHD PHENOMENA IN THE LIQUID METAL OF THE IN-PILE LOOP IN THE BN-600 UNIT AT THE BELOYARSK NUCLEAR ELECTRIC PLANT

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 246, No 3, 21 May 79
pp 593-596 manuscript received 6 Dec 78

KIRKO, I. M., Academician, Academy of Sciences LatvSSR, and KIRKO, G. YE.

[Abstract] A theoretical analysis is made of the feasibility of experimental observation of magnetic field amplification and the α -effect in the liquid-sodium coolant of the in-pile loop of the fast reactor in the BN-600 unit at the Krasnoyarsk Nuclear Electric Plant. It is shown that the sodium flow has a considerable effect on an externally applied magnetic field, which can be utilized in developing methods for internal inspection of hydraulic processes in the equipment. The liquid-metal system in this reactor is a complex of currents and fields with fairly high magnetic Reynolds number. The α -effect may lead to redistribution of current in the reactor, which will show up externally as increased hydraulic drag in the system. Figures 3; references 5: 4 Russian, 1 Western.

[143-6610]

USSR

NONLINEAR STIMULATED RAMAN SCATTERING WITH MULTIMODE PUMPING IN A DISPERSING MEDIUM

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR in Russian Vol 14 No 2, 1979
pp 94-99 manuscript received 30 Nov 78

DZHOTYAN, G. P., Yerevan State University

[Abstract] A solution is obtained to the equations of stimulated Raman scattering with multimode pumping in a dispersing medium where the intensity of any one pumping mode, say the center $n = 0$ mode, exceeds by far the intensity of all other pumping modes and the intensity of the Stokes wave. No depletion of the "strong" mode is assumed to occur during the process of stimulated Raman scattering. The solution is general enough to cover both coherent and noncoherent scattering as well as the transition range between the two extremes. References 10 (Russian).
[159-2415]

USSR

UDC 772.773

VANADIUM OXIDE FILM AS A RECORDING MEDIUM IN HOLOGRAPHY

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1459-1463
manuscript received 27 Oct 78

EUGAYEV, A. A., ZAKHARCHENYA, B. P. and CHUDNOVSKIY, F. A., Leningrad, Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] On the premise that the vanadium dioxide VO_2 and other $(V O_{n/2n-1})$ films used so far in holographic recording are not optimal (owing to shortcomings in their manufacture), the vanadium oxide VO film forming during the oxidation of vanadium film in air is investigated. Such film displays phase-transition capability and can transmit optical information, as shown by J. Balberg and S. Trokman (J. APPL. PHYS., Vol 46, p 5, 1975). Investigation of the optical properties of VO films shows that they can be used for multiple recording of holographic information. The films were obtained by means of the vacuum deposition of an aluminum film on a substrate, with subsequent deposition of a vanadium film and its oxidation. The diffraction efficiency of the holograms recorded on these films with the aid of a pulsed ruby laser was found to be 1.4% for $\lambda = 0.63 \mu m$, which is high compared with 0.5 for the standard FTIROS holographic recording medium. VO films were successfully used to record the IR interference pattern of a silicon wafer. Figures 4; references 16: 10 Russian, 6 Western.
[157-1386]

USSR

SELF-FOCUSING OF WAVE BEAMS WITH PLATEAU-LIKE INTENSITY DISTRIBUTION

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 30 No 2, 20 Jul 79 pp 119-122 manuscript received 6 Jun 79

AMOSOV, A. A., BAKHVALOV, N. S., ZHILEYKIN, YA. M., KOROBKIN, V. V., PROKHOROV, A. M. and SEROV, R. V., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Numerical computer simulation of the propagation of powerful wave beams with a gaussian intensity distribution in nonlinear media has shown that such propagation is accompanied by the formation of a multiple-focus structure, with the number of foci being roughly equal to P/P_{cr} , where P is the total power of the beam and P_{cr} is the critical power. Power roughly equal to P_{cr} enters into each focus. However, a broader understanding of this pattern requires investigating beams with some sufficiently arbitrary form of initial intensity distribution (IID). Accordingly, a plateau-like form of the IID was numerically investigated on a BESM-6 computer with respect to a time-dependent differential equation of a Kerr type nonlinear medium with three-photon absorption. It is shown that only one focus can form at self-focusing of axisymmetric wave beams with a plateau-like IID. Even if the IID is gaussian, it can be distorted during propagation of the wave beam, not only owing to the nonlinearity of the refractive index but also for other reasons, such as stimulated Mandel'shtam-Brillouin scattering. Figures 2; references 5 (Russian).

[161-1386]

USSR

QUASI-LINE RADIATION OF SOLID NEON UPON TRANSITIONS BETWEEN EXCITED STATES

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 30 No 2, 1979 pp 126-129 manuscript received 13 Jun 79

BELOV, A. G., SVISHCHEV, V. N., FUGOL', I. YA. and YURTAYEVA, YE. M., Physico-Technical Institute of Low Temperatures, UkrSSR Academy of Sciences

[Abstract] The radiation spectrum of solid Ne virtually lacks a continuum, but there exists a group of lines between 6150 and 7950 Å which cannot be ascribed to any secondary processes. In this connection, the cathodoluminescence spectrum of neon cryocrystals was investigated: the visible luminescence of solid Ne was found to be located in the 8000-6000 Å region and

to represent a group of 26 narrow bands, virtually lines, whose width does not exceed 1.5 cm^{-1} , and which correspond to transitions between excited $2p^5 3p \rightarrow 2p^5 3s$ states (two excited terms of the Ne atom). Each band consists of a narrow phononless line and a phonon wing. The wavelengths of the phononless lines coincide correct to 1 \AA with their atomic counterparts. This astonishingly close frequency coincidence prompted spectroscopic experiments which demonstrated that the radiation originates from the solid specimen and not from the gas. On this basis the mechanism of the formation and selective population of local $3p$ levels in solid Ne is attributed to dissociative recombination within the readily deformable lattice of Ne, which results in the formation of directly local quasiatomic states of $3p$. This mechanism as well as the visible luminescence of neon account for the extremely intense radiation from $3s$ states to the ground state in the far-UV region. Figures 3; references 4: 2 Russian, 2 Western.

[161-186]

USSR

UDC 621.372.826.038.825

SHORT CERAMIC SECTION OF A CO₂ WAVEGUIDE LASER IN THE AMPLIFICATION MODE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1567-1570
manuscript received 20 Mar 78

KUZYAKOV, B. A., Moscow, Institute of Radio Electronics, USSR Academy of Sciences

[Abstract] The use of CO₂ waveguide lasers and amplifiers attracts increasing interest in connection with the problem of reducing the dimensions and weight of quantum devices. Miniature discharge tubes can also be used as intermediate amplifiers in fiber-type communication lines operating at the 10.6 μ m wavelength. But since the direct extrapolation of measurements of the amplification factor is difficult owing to the nonlinearity of characteristics and the presence of fringe effects, the amplification factor was investigated on a working model of a CO₂ waveguide laser. The investigated discharge tube was constructed from a set of heat-conducting BeO ceramic plates joined together with epoxy so as to form a 4 mm long discharge duct with a square cross section of 1 x 1 mm. One of the plates contained cylindrical apertures of 0.5 mm diameter into which were inserted nickel electrodes for maintaining the temperature of the external surface of the tube at 18°C. The gain was measured as a function of the mean pressure of the active mixture CO₂:N₂:He = 3:2:5. It is established that active mixtures that contain xenon result in higher gain. When the external surface of the discharge tube remains at room temperature, and in the presence of relatively low pumping (≤ 150 -200 ma/cm²), and when the gas mixture contains Xe, the weak-signal gain can be as high as 12-15 dB/m at pressures exceeding 100 mm Hg. An analytic formula for determining the gas temperature in relation to the heat conduction of the gas mixture, the material of the tube, and the parameters of pumping, is derived. Figures 4; references 9: 4 Russian, 5 Western. [157-1386]

AN OPTICALLY CONTROLLED DEFLECTOR BASED ON A THIN-FILM WAVEGUIDE

Moscow KVANTOVAYA MEKhanika in Russian Vol 6 No 7, 1979 pp 1580-1582 manuscript received 24 Jan 79

BEREZIN, P. D., BUACHIDZE, Z. E., SEMENOV, A. S., UDALOV, N. P. and SHAPKIN, P. V., Moscow, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] So far a light beam propagating through a dielectric waveguide has been chiefly controlled by means of electrical methods for varying the refractive index. At the same time, it is of interest to investigate the possibility of contactless control of the light beam by means of external optical radiation considering that the optical properties of photosensitive semiconductor materials may markedly vary under the action of light of specific frequencies. To this end, a 4 μm thick $\text{CdS}_x\text{Se}_{1-x}$ layer, obtained by diffusing selenium into a bulk substrate of single crystal CdS, was used as a thin-film waveguide through which was passed the beam of a He-Ne laser ($\lambda = 0.63 \mu\text{m}$). The photoexcitation of the waveguide layer was accomplished by focusing the radiation of an argon laser on the waveguide surface. The deflection of that beam was then investigated, and it was established that the refractive index of the part of the waveguide illuminated by the argon laser increases owing to photoemission and acts as a positive lens. The deflection of the beam is associated with the local induced variation in the refractive index owing to the absorption of the shortwave radiation of the control laser in the photoconductor. The deflection time of the beam is $\sim 10^{-7}$ sec. The use of an external optical signal to control the beam propagating in a photoconductor waveguide is a promising new technique. Figures 3; references 4: 3 Russian, 1 Western.

[157-1386]

USSR

EXPERIMENTAL DEPENDENCE OF THE VOLUME OF SOLID NORMAL HYDROGEN ON PRESSURES OF UP TO 30 Kbar AT A TEMPERATURE OF 77 K

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 76 No 6, 1979 pp 2194-2197 manuscript received 12 Jan 79

KECHIN, V. V., PAVLYUCHENKO, YU. M., LIKHTER, A. I. and UTUZH, A. N.,
Institute of High-Pressure Physics, USSR Academy of Sciences

[Abstract] Experimental P-V data on solid normal (75% ortho-, 25% para-) hydrogen at the temperature of liquid nitrogen are presented. The measurements were performed in a low-temperature press by the piston displacement method. The maximum pressures applied were 11 kbar in the beryllium bronze chambers and 17-29 kbar in the steel and Mn-Ni steel chambers. The specimens of solid hydrogen averaged 0.5-1.0 cm³ in volume. Empirical equations best describing the experimental findings are presented. On the basis of the findings on the P-V dependence the mean isobaric coefficient of volumetric expansion $\bar{\alpha}_p = (\Delta V/V\Delta T)_p$ is estimated. It is established that $\bar{\alpha}_p$ rapidly decreases ($\bar{\alpha}_p \sim 1/P$) with increase in pressure: at 5 Kbar $\bar{\alpha} \approx 7.5 \cdot 10^{-4} \text{ deg}^{-1}$ whereas at 25 Kbar $\bar{\alpha} \approx 1.4 \cdot 10^{-4} \text{ deg}^{-1}$. In addition, the relative increase in volume during the melting-crystallization phase transition was found to be $(4.7 \pm 0.4)\%$. Figures 2; references 14: 4 Russian, 10 Western.

[152-1386]

USSR

PHASE STRATIFICATION OF A HOMOGENEOUS SUPERCONDUCTOR IN A MICROWAVE FIELD

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 29 No 12, 20 Jun 79 pp 758-761 manuscript received 30 Apr 79

DMITRIYEV, V. M. and FHRISTENKO, YE. V., Physicotechnical Institute of Low
Temperatures, Academy of Sciences USSR

[Abstract] Experiments are done to confirm the theoretical prediction of transition of a homogeneous superconductor to a spatially inhomogeneous state in a microwave field [B. I. Ivlev, ZhETF, Vol 72, 1977, p 1197]. The current-voltage characteristics were determined with microwave exposure on thin (1000 Å), narrow (1-2 μm) and long (100 μm) tin specimens. Current stratification is clearly apparent in the absence of a microwave field (-55 dB). As the microwave power is increased, the critical current rises, and the specimen becomes more homogeneous with respect to the order parameter. At a power on the -22 dB level the stimulation of superconductivity reaches a maximum, and then decreases with increasing microwave power. Then in a very narrow region (between -19.35 and -19.3 dB) the critical current abruptly vanishes. The resistance of the specimen in this new state is 0.9 Ω, and a phase-stratified structure arises with increasing direct current, displaying five regions with dynamic resistance approximated by multiples of 0.9 Ω. When the microwave power increases to -18.6 dB, there is another stepwise change in the state of the specimen and the resistance doubles to 1.8 Ω at zero DC current. As current increases, the spatial stratification occurs at multiples of 0.9 Ω. At a field power corresponding to -18 dB there is another jump in zero-current resistance to 2.7 Ω, and the specimen then undergoes a transition to the normal state at -17 dB. This behavior agrees with the theoretical prediction of transition of a quasi one-dimensional superconductor to a spatially inhomogeneous resistive state in a microwave field with characteristic N-S stratification. Figures 2; references 7 (Russian).

[164-6610]

USSR

THRESHOLD INSTABILITY AND INHOMOGENEOUS STATE IN NONEQUILIBRIUM SUPERCONDUCTORS
WITH OPTICAL PUMPING AND TUNNEL INJECTION OF QUASIPARTICLES

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 76,
No 6, 1979 pp 2218-2229 manuscript received 23 Jan 79

YELESIN, V. F., Moscow Engineering Physics Institute

[Abstract] It is shown that the development of threshold instability in nonequilibrium superconductors with a narrow source of quasiparticles (optical pumping and tunnel injection) can result in transition to an inhomogeneous state representing regions with different finite values of the order parameter (nonzero), in connection with the fact that once the pumping power (or injection rate) reaches a certain critical value the homogeneous superconductor becomes stratified into regions of normal ($\Delta = 0$) and superconducting ($\Delta \neq 0$) phases. In this connection, it is shown that the developed theory of threshold instability satisfies the condition $\omega - 2\Delta \ll \Delta$, $V - 2\Delta \ll \Delta$ (where ω is the electromagnetic field frequency, V is the junction voltage and $\omega - \Delta^2$ is the source width), predicted in an earlier study by the author (ZHURNAL EKSP. I TEOR. FIZ., 66, 1976, p. 1755). Figures 3; references 23: 16 Russian, 7 Western.

[152-1386

USSR

UDC 621.375.8

A NEW METHOD FOR THE THEORETICAL CALCULATION OF THE CHARACTERISTICS OF AN ATOM IN A STRONG ELECTROMAGNETIC FIELD

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 6 No 7, 1979 pp 1409-1415 manuscript received 25 Sep 78

GRISHANIN, B. A., Moscow State University imeni M. V. Lomonosov

[Abstract] The quantum dynamics of an atom in a strong field still needs elucidation owing to the variability of the properties of nonmonochromatic fields and to the need for a more economical mathematical description of the stochastic dynamics of the atom: through the introduction of adequate mathematical definitions and a corresponding qualitative terminology, the stochastic dynamics of the atom can be represented in compact notation and maximally graphic form convenient for computerization, and can moreover be extended to apply to varied processes in a multi-level atom. In this connection, the advantages of such a procedure are illustrated here for a two-level system in a strong electromagnetic field. It is shown that the matrix representation of the Markovian evolution operator serves to allow for any fine effects. The proposed method is based on an explicit introduction of the concept of quantum conditional probability distributions for stochastic quantum systems, with these distributions being handled by a procedure completely analogous to the operations of classical probability algebra. Thus, any characteristics of an atom or a molecule with a known spectrum, existing in a strong external field of sufficiently arbitrary form, can be practically calculated within the framework of a single program. The next stage of pertinent research will consist in refining the class of problems of primary practical interest and in implementing the corresponding specific procedures in a form optimal for a general computer routine. Figures 1; references 11: 6 Russian, 5 Western. [157-1386]

USSR

UDC 519.833

NON-COALITION GAMES OF THREE PERSONS WITH FIXED HIERARCHICAL STRUCTURE

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian
Vol 19 No 4, Jul/Aug 79 pp 896-911 manuscript received 3 May 78

KUKUSHKIN, N. S., Moscow

[Abstract] Hierarchical games are those with a fixed sequence of moves. Games for three or more players have been studied in a number of earlier works, but in all of these reports only one particular player operates actively, while the others either form a coalition or maximize their own winnings independently, without attempting to influence the moves of their partners. In either case, the potentially multilevel game degenerates to a two-level game. This article suggests a generalized hierarchical solution for non-coalition games of many persons, allowing games-theory analysis of multilevel hierarchical systems. For simplicity, the analysis is limited to games of three persons, since a further increase in the number of players does not basically alter the structure of the solution. By solving a sequence of optimization problems, the first player can achieve the best guaranteed result. Strategies to be used in cases when information concerning the moves of other players is limited are also analyzed. An illustrative example is appended. References 11 (Russian).
[155-6508]

USSR

UDC 519.83

DYNAMIC GAMES WITH HIERARCHICAL INTEREST VECTOR

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian
Vol 19 No 4, Jul/Aug 79 pp 912-920 manuscript received 14 Jun-78

SHANANIN, A. A., Moscow

[Abstract] In constructing a model of a socio-economic system, one must consider that various elements of the system have different goals. Simplified, static games models have been analyzed previously, considering the differences in the interests of various elements of such a system. In this work, analogous dynamic models are studied, in the approximation of discrete time. The players are assumed to make up a group with several hierarchical levels, one of which is the group as a whole. References 3 (Russian).
[155-6508]

CSO: 1862

USSR

UDC: 536.248:517.972.5

VARIATIONAL PRINCIPLES OF PHENOMENA OF NONLINEAR ANISOTROPIC INTERRELATED TRANSPORT

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR. SERIYA FIZICHESKIKH I TEKH-NICHESKIKH NAUK in Russian No 2, 1979 pp 51-59 manuscript received 11 Sep 78

GLAZUNOV, YU. T., Institute for Skill Improvement of Managerial Workers and Specialists in the Fishing Industry

[Abstract] In previous studies, variational principles have been proposed for phenomena of nonlinear interrelated transport of an arbitrary number of substances for the case where these effects occur in isotropic media. The approach suggested for these variational principles can be generalized to the case of an anisotropic medium, where the transport coefficients in the equations are tensors. This can be observed for instance in the case where the conduction coefficients of the medium for the different substances taking part in a process depend on the directions of transport because of anisotropy of the medium. In this paper the author constructs variational principles for such phenomena with regard to dependence of transport coefficients on transport potentials. A variational principle is constructed for the case of a continuous medium with nonlinear anisotropic characteristics with consideration of transport coefficients as tensors of the second rank with components that depend on spatial coordinates, time, and transport potentials. A supplementary form of the variational principle is derived for phenomena of anisotropic interrelated transport in the case where the transport coefficients depend on transport potentials, while sources of substances operate within the investigated volume that depend nonlinearly on the transport potentials. References 5 Russian.

[104-6610]

CSO: 1862

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